

quarterly journal

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The
University
Of
Sheffield.

Advanced Manufacturing
Research Centre



Bucking the trend

AMRC Training Centre has record year

AMRC Castings group celebrate largest ceramic shell titanium casting created from a single pour in Europe

Pioneering consortium develops paperless aerospace MRO system

Major US science-based and innovation company join AMRC to accelerate development of new technologies

CATAPULT
High Value Manufacturing

 **European Union**
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Welcome to our quarterly journal



Making people and production smarter

This issue of the Journal comes just weeks after the publication of the Government's much anticipated Industrial Strategy White Paper, which itself followed hot on the heels of the Industrial Digitalisation Review, Made Smarter. Both these 'strategies' are discussed in this issue as they will have profound implications not only for the AMRC but for the wider UK economy: particularly, the response to the troubling problem of productivity.

One of the ways of raising productivity is to raise skill levels. Kerry Thompson's article about the success of the AMRC Training Centre shows how, by working closely with more than 250 regional small and medium sized manufacturing firms, we have been able to buck the national trend on apprenticeship numbers. By helping local firms understand the often fast changing and confusing landscape of training funding, she and her team have enabled them to maximise the benefits of apprenticeships for their businesses.

Rather than experiencing a decline following the introduction of a new levy for bigger firms, we have seen a continued increase in numbers, with this being a record year for the Training Centre, taking to over 1,000 the number of school leavers we have trained. 2017 also saw our first cohort of degree level apprenticeships – the bright, young engineers of the future – fulfilling our ambition to widen access to higher education to those parts of our community who might previously have thought that the path to a university degree was closed to them.

The centre draws ambitious young people from across the wider Sheffield City Region, including more than 60 apprentices from Doncaster and Barnsley. We saw in the Budget, and again in the Industrial Strategy,

that government investment is favouring those regions that have elected a strong Metro Mayor. Places like Manchester, Liverpool and the North East. Our region is losing out on this investment: it is time we came together.

On a more personal note, I would like to pay tribute to a remarkable engineer and a remarkable friend: Bart Moenster. Bart was a founding father of the AMRC. It was his belief in our vision for a world-class centre of engineering excellence here on the Sheffield and Rotherham border that enabled us to get off to a flying start. For 16 years he has been the Chairman of the AMRC board. His wise counsel, diplomatic skills, and sound judgement, have guided us on the path to continuous improvement and growth.

While his retirement marks the end of era, he is handing over the baton to a very safe pair of hands in the form of Peter Hoffman. Peter, who has been with us since the start of our journey, is Boeing's vice president of Intellectual Property Management. Before that, however, he was the director of global research and development strategy for Boeing Research & Technology, where he was responsible for developing technology collaboration relationships with companies, universities and national laboratories around the world. We are honoured that a figure of Peter's stature and experience at the highest levels within a global company, is taking the Chairman role.

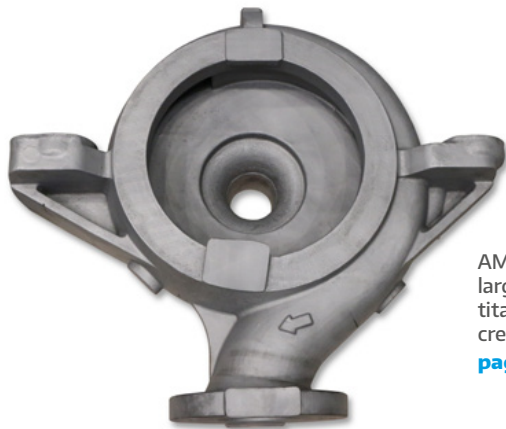
Prof Keith Ridgway, CBE.

Executive Dean of the
University of Sheffield Advanced
Manufacturing Research Centre Group



AMRC FACTORY 2050 CONFERENCE: WHERE DIGITAL MEETS MANUFACTURING

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AMRC Castings unveil largest ceramic shell titanium casting ever created in Europe
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After 16-plus years as Chairman of the AMRC with Boeing, Bart Moenster officially retires
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AMRC Forum: Opportunities and
challenges in the automotive sector
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Craftsman Tools wins Innovate UK grant for intelligent tool-holding

Craftsman Tools Ltd have been awarded a grant by Innovate UK to develop intelligent tool-holding for metal-cutting machine tools.

Craftsman Tools Ltd is a multi-award winning UK precision engineering company specialising in innovative solutions for tool-holding, work-holding and supply chain management services and solutions.

In partnership with the University of Huddersfield, Craftsman Tools Ltd seeks to create new intelligent tool-holding by incorporating "Internet of Things" (IoT) sensing technology with dynamic models; enabling the prediction of surface finish during machining, and the ability to bore a hole with a greater length-to-diameter ratio, combating challenges facing many industries, including aerospace.



Part of Craftsman Tools' range of split boring bar holders, which are being adapted as part of the project.

This project not only aspires to improve the productivity of the end-users, launching a series of new innovations from the tool-holding suppliers, but also to benefit the environment and increase education. The end products should reduce drilling time by 10 per cent, in turn reducing energy waste, and Craftsman Tools award winning apprentice school will provide valuable insight to students at University Training College Leeds.

Craftsman Tools will concentrate on

optimised mechanical designs and will provide vital information to guide the requirements for sensors and analytics and lead the cutting trials, whilst the University of Huddersfield will provide the expertise in the sensor technology, modelling and analytics.

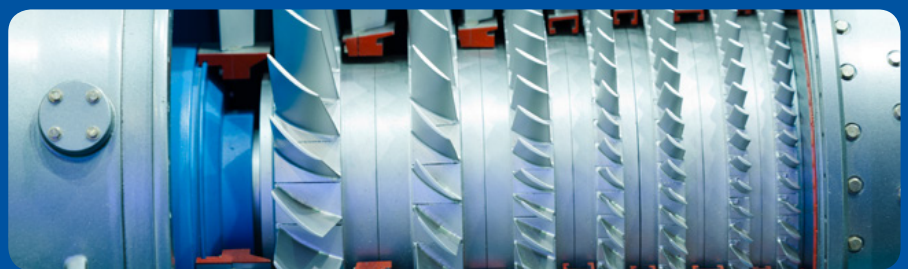
With 80 per cent of Craftsman's tool-holding sold worldwide, the results of the grant will be advantageous to UK manufacturing as a whole, with Craftsman Tools at the forefront of global tool-holding solutions.

Intelligent manufacturing solutions halve production time of gas turbine components

Metrology software products Ltd (MSP) a global company committed to the research, development and installation of world class precision software and part manufacturing solutions has joined forces with Renishaw to provide a vital solution for customer, Doncasters Precision Castings – Deritend. The company is a leading manufacturer of investment cast and machined industrial gas turbine airfoils.


The challenge was to improve right first-time machining rates of industrial gas turbine airfoils and nozzles and, in doing so, eliminate potential for errors to arise, as well as increasing overall productivity. Another challenge was to eliminate the need for costly and time-consuming hard fixturing.

An Applications Engineer from Renishaw, recognised that MSP's NC-PerfectPart and NC-Checker Software



combined with a Renishaw RMP600 probe would provide the best overall solution for Doncasters' requirements. This combination of hardware and software allows users to identify errors in part positioning and a machine's geometric performance prior to a part being cut. Set-up is automated, meaning that fixturing is no longer as critical in the process, manual set-up error is eliminated and the time required to set even the most complex of components is reduced to minutes.

Before this solution, it took four hours to set and machine a typical industrial gas turbine nozzle. Now that same part can be probed, machined and checked in less than two hours, increasing productivity by 100 per cent. With complex components, the machining time could be up to eight hours and require the presence of a highly skilled operator to oversee the process. These parts are now produced in the same two-hour cycle as simple parts, generating greater savings.



3M Science.
Applied to Life.™

Time for
innovation
and science

With 8,500 of its own researchers around the world, you might think that the US-headquartered 3M has little need to partner with other organisations. But, last month, the global bearings and turbine arm of this US \$30 billion a year business joined the likes of Boeing and Rolls-Royce as an AMRC industrial partner.

Next time you stick a Post-it® note to the fridge door you will have used a 3M product. With more than 200 manufacturing plants across 28 countries, the sticky, yellow reminder slip is just one of the more than 55,000 products developed and made by 3M.

"We are a science-based and innovation company," says Chris Harford, who leads the bearings and turbines side of 3M's Precision Grinding and Finishing business. Other segments include gears; automotive; tooling; and primary metals.

He points out that while 3M invests heavily in its own research facilities; its work with the aerospace industry makes Tier 2 membership of the AMRC a natural fit.

"The AMRC allows us to test our technologies to the limits, says Harford. "The AMRC also provides a space for us to accelerate the development of new technologies and products. The relationship allows us to get closer to the end user by engaging us at the

pre-production stage, which is vital to our business, and to understand the ways in which a fast-changing industry is moving. If we can support early development, it helps us deliver the right solutions."

This is no one-sided partnership, however. 3M is supporting the AMRC in the exploration of new and often difficult-to-machine materials, many of which are super light and with good creep resistant properties that could form an increasingly vital part of future aircraft construction.

On a recent visit to 3M's research and innovation centre in Bracknell, AMRC Group Executive Dean Professor Keith Ridgway was impressed with the way so large an organisation was able to foster an environment where researchers are encouraged to think creatively.

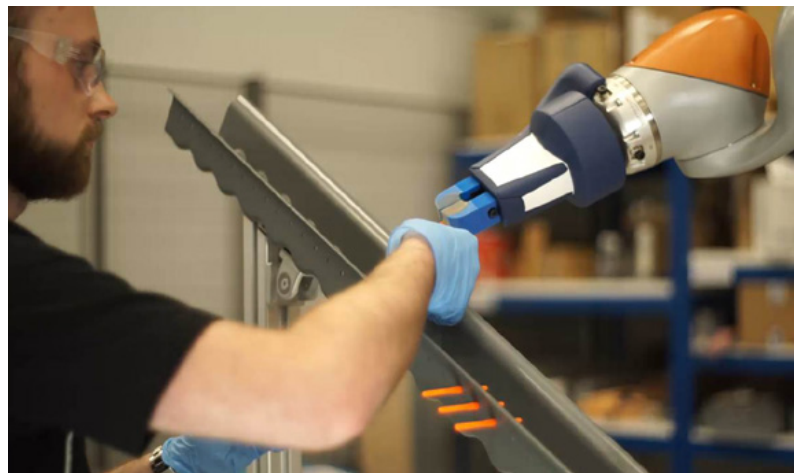
The bold 15 per cent programme allows employees to use a portion of their paid time to chase rainbows and hatch their own ideas. It might seem like a gimmick, but the time has actually produced many of the company's best-selling

products and has set a precedent for some of the top technology companies, like Google and Hewlett-Packard. Much of that time is spent thinking about what the world will look like in the future.

"Like the AMRC and its ultimate end users we are very interested in what the industry will look like in five, ten, 20 years' time," said Harford. "We see the AMRC as a valuable bridge between fundamental research and industrial application."

David Curtis, Technical Fellow in the grindings strand of the AMRC's Machining Group, says that 3M is an ideal partner. "They understand the importance of good science and engineering," said Curtis, who recently gave a keynote presentation to 3M's manufacturing plant in Austria.

"It was good to be able to talk directly to a group of very talented people who understand the value our research partnership can bring to new product testing and development."



BAE Systems in collaboration with the AMRC and The University of Sheffield have been working to develop collaborative robotics

Collaborative robots (cobots) have been in existence for a few years, but uptake in manufacturing has been difficult and slow. BAE Systems in collaboration with the AMRC and The University of Sheffield have been developing a manufacturing demonstration based upon bonded nutplates or “clickbonds”.

The development itself enabled a clickbond to be picked up by the robot, have the adhesive applied and then

hand it to an operator. Although early in its development phase it is considered this technology could be beneficial in reducing waste and removing tasks which could cause Health and Safety issues.

This technology allows the human and robot to share elements of a task they are each suited to.

The technology demonstration has been developed into a portable exhibition stand, to enable collaborative robotics

and their benefits to be seen by a wider audience, to aid technology uptake.

As part of this exhibition development, the cobot has been linked with a National Instruments interface and a wireless tablet control and formed part of BAE Systems stand at the Defence and Security Equipment International show in September 2017.

New good practice guidance on the safe use of metalworking fluids

The Health and Safety Executive (HSE) is revising existing guidance to support priority health campaigns and to incorporate feedback from industry.

The guidance explains why and how to maintain metalworking fluids (MWFs), including the fluid checks and testing frequencies required. This will be enforced with random visits by Field Inspectors. These inspectors have a range of punitive actions available to them, including a levy of service charges for their time and work done. The HSE also have the authority to issue fines for severe breaches of duty.

The new guidance is for those with responsibility for control and management of MWFs. The requirements are similar to the existing guidance with important changes in certain areas e.g. fluid testing, improving air quality, and use of PPE.

The new HSE guidance will be issued as a pocket booklet, workshop poster and updated on the HSE website.

As before, employers are required to carry out a suitable Risk Assessment (RA) to ensure that exposure is prevented and adequately controlled.

HSE Field Inspectors will assess employers based on their RAs and the



requirement to inform and train all employees about risks and hazards, and the provision of adequate health surveillance programmes and upkeep of appropriate records.

As a responsible supplier Houghton have a comprehensive range of products and services available to ensure our customers remain fully compliant with this new guidance.



Bharat Forge conduct research trials on abrasive water jet drilling underwater on CFRP material

The Kalyani Centre for Technology and Innovation at Bharat Forge in India has conducted underwater drilling trials of carbon fibre reinforced polymer (CFRP). Composite laminates such as CFRP, glass fibre reinforced polymer (GFRP) and fibre metal composite laminates are used in aerospace and other industrial applications due to its extremely high strength to weight ratio and corrosion resistance properties.

These composite laminates are difficult to machine materials however, which results in low drilling efficiency and drilling-induced delamination. Developing an innovative advanced drilling process such as abrasive water jet drilling can overcome the difficulties experienced in the machining of composite materials.

In this non-conventional drilling process, an underwater drilling technique was used and it was observed that this technique was more suitable for controlling delamination, hole surface roughness and exit hole size variation.



The Kalyani Centre for Technology and Innovation.

In this drilling technique, the material was placed under the water, with the water being the medium in between the material and jet while drilling.

During the drilling process the water jet stream has highest kinetic energy for cutting the material. Excess kinetic energy of the water jet is absorbed by

the water medium i.e. the energy which was responsible for development of high delamination during drilling operation. The Kalyani Centre for Technology and Innovation have found using this method of propagation of water leads to reduced delamination, less exit hole size variation and good hole surface finish.

Bharat Forge conduct research into how to improve performance of conventional tapping processes

A large number of highly accurate tapped holes over large depths and small diameters are required in aerospace industries. However, sudden breakage of a tap is the most undesirable event frequently encountered during tapping on titanium alloys; primarily due to excessive torque.

The low elastic modulus and thermal conductivity of titanium alloys generate a large spring back from finished surfaces and also cause a thermal gradient at tapped cutting edges. This results in galling and seizing around the cutting edges.

The consequent relief face friction causes locking and subsequent breaking

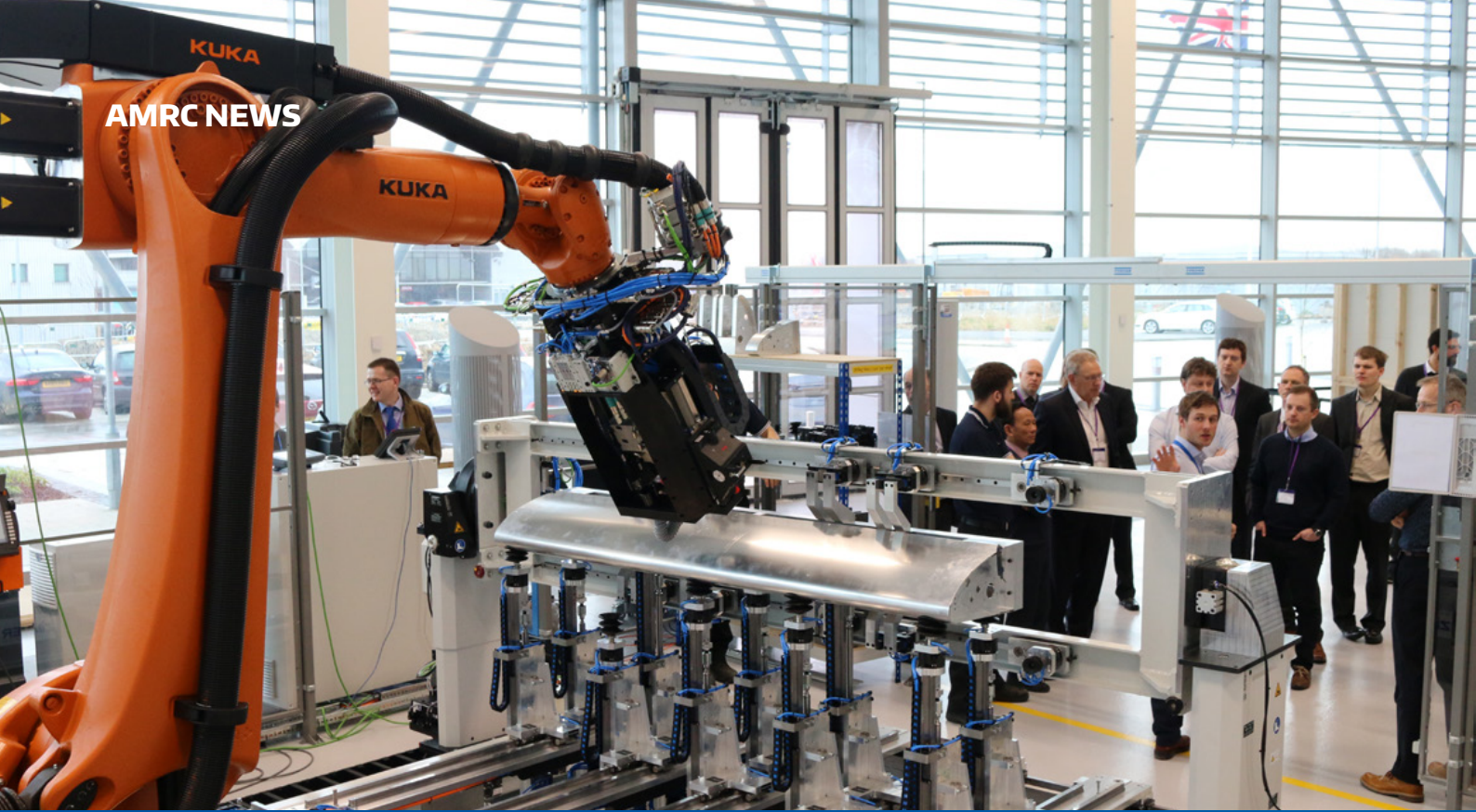
of rotating taps in the drilled hole. As tapping is one of the final operations performed on a component, the tap breakage at this stage is always costly. Therefore, it is necessary to study the tapping process and evolve alternatives to overcome these limitations.

The work conducted by the Kalyani Centre for Technology and Innovation at Bharat Forge involved extensive experimentation to investigate the performance of tapping in titanium alloys in the presence of axial and, axial and torsional vibrations.

Introducing controlled axial as well as torsional vibrations in conventional tapping processes improves the tapping performance in terms of reduction in

torque, force and temperature. The ATVAT (Axial and Torsional Vibration Assisted Tapping) encounters minimum tapping torque, axial force and temperature over that in conventional tapping (CT) and AVAT (Axial Vibration Assisted Tapping).

The axial and torsional vibrations appear to enhance the effect the cutting fluid in terms of higher degree of reduction in torque and temperature. The ATVAT generates elastic recovery free surfaces with lesser average surface roughness (Ra) than that of in CT and AVAT. The depth of the machining affected zone goes on decreasing as vibrations are added to the conventional tapping processes.



Completion of UK aerospace research project celebrated with AMRC showcase

The successful completion of a major UK aerospace research project has been celebrated with a showcase of presentations and live demonstrations at AMRC Factory 2050.

The showcase was a celebration of one of the most ambitious programmes of work the AMRC's Integrated Manufacturing Group (IMG) has ever undertaken.

The Validation & Integration of Manufacturing Enablers for Future Wing Structures (VIEWS) programme brought together a total of 13 partner organisations from industry, academia and the High Value Manufacturing Catapult (HVMC), of which the AMRC collaborated with GKN Aerospace, GE Aviation, Spirit AeroSystems and Bombardier.

The partners came together to support a broad spectrum of work, with the aim to protect and exploit the UK's collective strengths in aerospace wing manufacture; working together to develop the manufacturing technologies and production processes of the future for UK aerostructure production.

Chris Greaves, Operations Manager at Factory 2050, said: "The event was held for our research partners, to showcase the incredible range of projects that were carried out over three years.

"These projects explored themes such as automation and integration of key

production processes, testing methods and the development of tooling and fixturing."

The AMRC worked in partnership on 19 of the 60 VIEWS work packages, jointly funded by industry, Innovate UK and the Aerospace Technology Institute.

The contributions IMG made to seven of these work packages included investigating advancements in robotic drilling, digital work instructions, assembly technologies, automated fixturing, shim application and the simulation of production processes and modelling to be applied to



manufacturing processes in use within the aerospace sector.

Chris Greaves said: "The VIEWS project intended to help aerospace suppliers retain and boost their presence within the UK and to take advantage of the wealth of talent and skills readily available to ensure they remain competitive and are able to meet future demand.

"The impact of such a huge consortium of partners coming together to conduct research into methods that will keep aerospace manufacturing competitive in the UK cannot be underestimated.

"As a direct result of the work done by the consortium, VIEWS has secured over 1900 jobs within Tier 1 aerospace manufacturers and secured over 2600 jobs within the UK supply chain.

"It is estimated that a further £20.4 billion of future product opportunities available for the UK aerospace industry will be as a direct result of the VIEWS project. This is a great example of how industry and academia can work together to create real opportunities and growth for UK plc."

The showcase was held at the AMRC's flagship development – Factory 2050 – the home of IMG and the UK's first factory entirely dedicated to conducting collaborative research into reconfigurable manufacturing technologies.

Delegates witnessed presentations about the research programme and live demonstrations of the manufacturing processes and technologies that have been developed under the project.



As a direct result of the work done by the consortium, VIEWS has...



SECURED OVER 1900 JOBS WITHIN TIER 1 AEROSPACE MANUFACTURERS

ESTIMATED THAT A FURTHER **£20.4 billion** OF FUTURE PRODUCT OPPORTUNITIES AVAILABLE FOR THE UK AEROSPACE INDUSTRY



SECURED OVER 2600 JOBS WITHIN THE UK SUPPLY CHAIN

Examples of the aerospace technologies and processes developed included:

A reconfigurable fixture for wing assemblies with an automated drilling system

An assembly cell was developed for Spirit AeroSystems to accommodate multiple products and processes, reducing cycle times, improving part quality and client capability for variable part production and manufacturing flexibility in wing manufacture.

The development of digital work instructions for fastener grip length measurement

A ruggedised tablet computer collects data during the drilling process for an aerospace wing about the depth of a hole, which is used to create real-time digital work instructions to advise an operator what size of fastener requires installation. This system removes the need for paper drawings to be interrogated, speeding up the process of assembly on aircraft and achieving higher right first time targets.

Improving wing bush installation processes

Research was done using data to develop models for predictive component tolerances to achieve improvements in current wing bush installation processes for GE. This improved quality safety and right first time figures, whilst reducing cycle time. The system improved manual operations with the use of collaborative robotic systems.

Reconfigurable fixturing for advanced wing small box assembly during liquid shim applications

A collaborative project developed an automated liquid shim application system that could control application during advanced wing small box assembly. The system accounts for variations in part tolerance, which reduces cycle time and improves part quality.



AMRC Castings unveil largest ceramic shell titanium casting created in Europe

The Castings Group of the AMRC has unveiled the largest ceramic shell titanium casting ever created from a single pour in Europe.

The casting is a milestone test piece and will become a showcase for development of the AMRC's titanium casting facility which became operational earlier this year.

The large-scale, near net shape casting is an industrial centrifugal pump housing, used for highly corrosive applications in the chemical and petrochemical sectors. It was poured from a 680kg melt with a 200kg finished part weight.

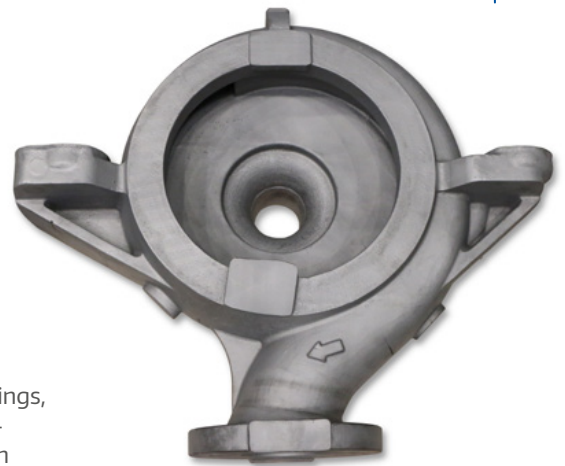
AMRC Castings' General Manager, Richard Cook, said: "This test piece is a significant step forward for us and the UK as a whole. We are the UK's only titanium melting facility and this achievement, sends a clear signal that the country is open for business on large-scale titanium casting services."

"Global capacity for titanium castings, particularly of this size, is scarce – indeed it has actually decreased in recent years, despite growing demand. There is a clear need for this kind of capability and our research and development will underpin the ability for the UK to remain competitive in a global market."

AMRC Castings is now working towards its goal of pouring over 1000kg of titanium for a 500kg part-weight centrifugal casting by May 2018, testing the boundaries and limits of its Retech consumable electrode castings furnace.

The furnace has three interchangeable crucibles capable of melting titanium for castings weighing up to 500kg and 2000mm in diameter by 2500mm in length.

The group is already dealing with enquiries from companies wanting to exploit the technology and are currently conducting paper studies and piloting



the first research projects.

Principal Metallurgist, Matt Cawood, said: "The AMRC are currently engaged in several projects looking to improve capability and technology to enable more complex, higher integrity components to be designed for manufacture with improved metallurgical quality and increased dimensional accuracy."

"Having the ability to pour large-scale castings as part of a research and development activity combined with the surrounding facility of industry-scale equipment and technical expertise is a unique offering that is drawing in many of the world's largest users of titanium castings to work with us."

Engineering and innovation bring notable success to the University of Sheffield

The University of Sheffield is celebrating the doubling of income for engineering research over the past four years, cementing its reputation as a leading centre for engineering and advanced manufacturing research and development.

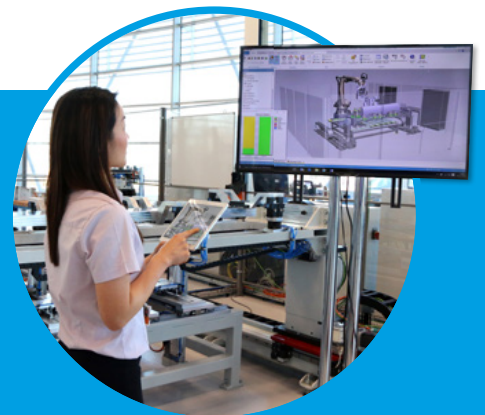
The University has the second highest research income in the UK for engineering – beating Cambridge University and only slightly behind Imperial College London.

The increase over recent years is a testament to Sheffield's reputation for innovation in engineering, especially in the area of advanced manufacturing.

Included in the research income figures is the work of the AMRC and Nuclear AMRC.

Professor Keith Ridgway, Executive Dean of the AMRC Group, said: "The growth of the AMRC has not only contributed directly to the increase in research income of the University, but directly to Sheffield City Region by attracting inward investment, creating new jobs and contributing directly to the health of the UK supply chain."

"The work we do developing advanced manufacturing technology and techniques helps businesses to grow and to remain competitive, and helps to boost the region as the UK's centre for advanced manufacturing."



Commenting on the increase, President and Vice Chancellor of the University of Sheffield, Professor Sir Keith Burnett said: "The extraordinary success of our engineers from computer scientists to the very latest in advanced manufacturing makes Sheffield an international leader in this crucial area of teaching and research.

"It is genuinely exciting to see what is happening, and we know this also offers extraordinary opportunities for students to engage with real life problems working with global brands."



Boeing begins construction on its first European production facility in Sheffield

Leading aerospace company Boeing ceremonially broke ground at the site of its new manufacturing facility on 12 September 2017.

The new 6,200-square metre Boeing Sheffield facility, due to open in late 2018, is situated alongside the AMRC's Factory 2050 and will be the company's first production facility in Europe.

It will manufacture actuation system components for Boeing's Next-Generation 737, 737 MAX and 777 aeroplanes – enhancing production efficiency and reducing costs whilst maintaining quality.

Boeing is also planning a major research and development programme with the AMRC to develop new manufacturing techniques that can be applied to the Boeing Sheffield facility and then implemented across Boeing internationally.

Sir Michael Arthur, President of Boeing Europe and Managing Director of Boeing UK and Ireland, said the company was proud to celebrate the ground-breaking of Boeing Sheffield and welcome more employees to the company.

He said: "Boeing Sheffield is further evidence of Boeing's long-term commitment to the prosperity of this country. We are grateful to the communities of Sheffield and Rotherham for supporting our growing presence in the region."

The facility will initially employ 30 people on opening, growing to more than 50 employees. This includes 19 manufacturing apprentices, who have already been recruited and are being



trained at the AMRC Training Centre.

Professor Ridgway, Executive Director of the AMRC Group said: "The ground-breaking today is an important event not only for Boeing, but for the AMRC, the University of Sheffield and the city region.

"It is the culmination of a partnership that began 17 years ago, and the realisation of a vision that one day we would see a Boeing manufacturing plant built in our region and employing skilled and talented local people."

Royal Air Force Bobsleigh Team hoping to slide to victory in sled revamped by AMRC Composite Centre

The Royal Air Force (RAF) bobsleigh team will compete in the UK Armed Forces Winter Sports Association's Inter Services Ice Championships in March 2018, in a bobsleigh given a new lease of life with custom composite repairs manufactured by the AMRC Composite Centre.

The thrilling extreme sport sees teams compete at speed to achieve the fastest time at Austria's famous Innsbruck-Igls Olympic bobsleigh, luge and skeleton track.

Until recently one of the team's two-man sleds had been out of commission following an impact that damaged its left bale, or wing at the front of the sled.

That is until RAF Bobsleigh Team Manager Cpl Ross Brown met AMRC Composite Centre Development Engineer Craig Atkins at this year's Cosford Air Show and was invited to visit the AMRC.

"We were keen to see if working together would be of benefit and to create partnerships with British organisations that may be able to help us further the sport," said Cpl Brown. "We were delighted the AMRC agreed to assess the various ways the damaged sled could be improved and carry out the substantial repair work it needed to get it back into service."

AMRC Composite Technician Josh Oxley the task of repairing the sled: "This is the first composite repair I was tasked with since qualifying as a composite technician, so it was a really exciting job to do. I engineered a new bale that was lighter which is important for the weight of the sled, but one that was also stronger and lessens friction on the track."

Cpl Brown said: "I was hugely impressed by the AMRC Composite Centre and the work carried out by Oxley went above



and beyond what I expected.

"Structural integrity of a sled is paramount when travelling at speeds of up to 100mph down a concrete tube covered in ice. Regarded as Formula One-on-ice, bobsleigh races are won or lost by hundredths of a second, so a quality repair is of the utmost importance to us."



Fit for purpose training



This has been another great year for the AMRC Training Centre. Our role in training the young engineers of the future is at the heart of transforming the skills base for the Sheffield City Region: a region with an international reputation as the go-to-place for advanced manufacturing with the likes of McLaren and Boeing securing multi-million-pound investments in production plants in 2017. Kerry Thompson, Director of the AMRC Training Centre writes.

This year has seen the AMRC Training Centre both expand and extend the range of apprenticeships we offer. The centre has been a trailblazer in establishing full degree apprenticeships, which combine real world, on-the-job training, with high quality teaching from leading academics at The University of Sheffield's Faculty of Engineering and research engineers from the AMRC, who can bring the foresight of emerging digital technologies into the programme to support industry in the region.

Some 26 ambitious learners are now on our degree apprenticeship course and the feedback from the learners and their employers has been very encouraging. One notable bonus of the degree apprenticeship has been a subtle change in attitude among schools. Where some schools have had a blind spot about

recommending apprenticeships in the past, the opening of the degree pathway is leading to a much more positive response from sixth forms across the region.

Another benefit from the degree apprenticeship has been the increased interest shown by female students. While it is too early to say why this should be, our early impression is that more and more young women are seeing this kind of degree as an attractive career option; developing practical skills while in employment, earning and learning at the same time.

The quality of our degree apprenticeships is such that it is now attracting industrial partners from outside the region, including companies from the Midlands' automotive sector who understand the added value of a degree apprenticeship linked to a leading Russell Group institution.

Workforce development does not stop at degree level. Our post-graduate engineering standard, which is breaking new ground, gives employers the opportunity to take graduates who may never have been out of university and get them onto the shop floor to train and develop them for more challenging

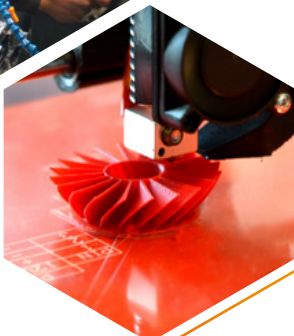
managerial and leadership roles. This versatility is one of the great merits of the new levy – more of which below – which allows employers to target training where it has most impact.

In our engagement with employers, we are helping them understand that the levy can also help them develop the leaders of future. In partnership with The University of Sheffield's internationally renowned Management School, we will be offering degree apprenticeships in management in 2018.

This will provide progression opportunities across different levels of management; from Level 3 which is aimed at first line leaders, through to higher level where advanced business improvement and lean methods are more fully explored and embedded.

As hinted at above, 2017 has been a year of change in the apprenticeship landscape at policy level. It is now nine months since the Government introduced the employers' levy with the ambitious goal of creating three million new apprentices by 2020.

Although there was some uncertainty among employers before its launch in April, the Training Centre overcame that risk by working closely with industry





to ensure they were able to maximise the benefits by upskilling their existing workforce, along with training new recruits.

So, instead of seeing a drop in numbers as had been talked about nationally, the AMRC Training Centre has seen a higher number of people come through, so our numbers have ramped up with 216 apprentices starting in September which is the highest number since we opened our doors in 2013.

We are incredibly proud that we now have more than 250 smaller and medium sized manufacturers from across the region willing to invest in the training and development of apprentices with the AMRC Training Centre. We see these companies as the engine room of the regional economy. Often, the most innovative ideas come from these SMEs and, in some cases, it is our apprentices who provide those innovations and insights.

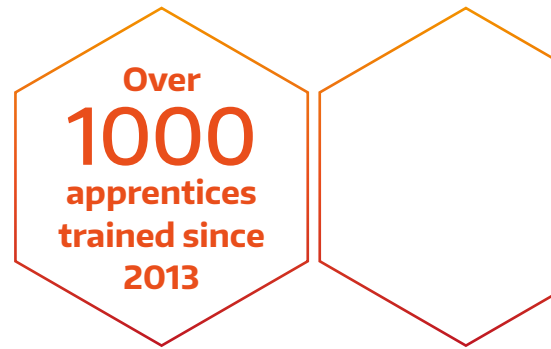
We have just supported the UK's biggest producer of wheelie bins in nominating one of their AMRC trained apprentices for a prestigious national award. Oliver Marsh has used lean methods to improve a key printing process that has significantly improved productivity and is estimated to have saved the company in excess of £150,000 already.

This year's Apprentice of the Year was not a young man, but a young woman:

Leigh Worsdale (see page 14). She works as an apprentice Heavy Duty Diesel Engine Builder for Foxwood Diesel in Chesterfield, and was awarded a trip to Boeing's factory in Washington State, outside Seattle to see first-hand how the global aerospace company designs, tests and builds its 737 aircraft.

Since then she has become an incredible ambassador for the AMRC Training Centre and an inspiration for young women to take up engineering as a career option. Leigh who builds big engines – 'they normally take two or three days to build' – felt it was great to be at the AMRC and meet so many other young people with the same interests. 'Learning about the mechanical and the technical side all in one has really improved my ability,' she said. Often on regional television and a sought after commentator around the time of A Levels, Leigh is a real apprenticeship champion.

Along with the levy, another key change this year has been the government reform of apprenticeships, with the current system of 'frameworks' being replaced by 'standards'. The standards are two-page documents listing the



skills, knowledge and behaviours needed for being competent in your role. We are now adopting some of these standards but are consulting closely with our industry partners to ensure that what we deliver is fit for purpose. And this is the key. Our Industry Board ensures we remain focused on the needs of the region's manufacturing community. It is also a forum through which we can transfer knowledge about the often fast changing apprenticeship landscape to our industry partners. This two-way process ensures we are delivering the right quality of apprentice to industry at the right time.





AMRC Apprentice of the Year tours famous aircraft manufacturer in USA

"If only we could build that many engines in a month!" Award-winning engineering apprentice Leigh Worsdale was left in awe after being given a unique opportunity to visit aerospace giant Boeing's American factories to see how its famous aircrafts are built.

Leigh Worsdale, 19, was invited to the USA after she became the first female to receive the Apprentice of the Year' award supported by Boeing at the AMRC Training Centre's 'Apprentice of the Year' awards held at The University of Sheffield earlier this year.

Leigh, an apprentice Heavy Duty Diesel Engine Builder for Foxwood Diesel in Chesterfield, enjoyed a whistle-stop tour of Boeing's sites in Los Angeles, Portland and Seattle; visiting areas not open to the general public.

"I never thought when I set off on my apprenticeship that I would be given an opportunity like this," said Leigh.

"It was amazing to see all the Boeing factories and see things and go to places which members of the public don't usually get to go."

For Leigh the most interesting part of the trip was the visit to Boeing's Renton Factory in Seattle where she got to see

first-hand how the global aerospace company designs, tests and builds its 737 aircraft.

Leigh said the efficiency and strict schedule the factory follows had left a huge impression on her as well as its sheer size.

The factory, which is an impressive 1.1 million square feet, has been able to ramp up production with a moving assembly line which has been likened to 'changing the wheels on a car as it's been driven.'

"The workers have to tie their chairs and tools to the planes if they move away from their workstation," said Leigh.

"If an issue occurs during the build, for example a missing part, the team gets alerted and an amber light flashes. If the problem cannot be resolved quickly and work stops a red light flashes. Usually the team can fix the issue in good time to ensure work is flowing.

"The factory is producing 42 aircraft a month. The production line is so efficient, a 737 aircraft is built every nine days.

"I found that remarkable!"

"It was like Foxwood Diesel on a much large scale!" said Leigh. "If only we could

build that many engines in a month."

Leigh has introduced a number of incentives at her company to improve the business which helped her to be named Apprentice of the Year.

One of those incentives is a stores system to easily locate engine parts, save time and reduce cost of delivery. Leigh was delighted similar systems are used at Boeing.

"It was great to see some of the systems I have brought in at Foxwood Diesel are the same as Boeing use, albeit on a much larger scale," she added.

During her visit Leigh also met her American counterparts at the Fabrication Plant in Portland where she likened the workshop where apprentices train as a smaller version of the AMRC Training Centre.

During the trip Leigh also got to try her hand at sailing at Union Lake in Seattle, visited the famous Pike Place Market, farmer's market established in 1907, and enjoyed some time on LA's famous Venice Beach.

She added: "It really was the trip of a lifetime but made even more special knowing I had earned the opportunity through what I have achieved as a University of Sheffield apprentice."





Argenta working with the AMRC to trial pioneering MRO system

Argenta Europe Ltd, an innovation ecosystem development organisation, is working with the AMRC through a pioneering consortium which aims to bring aerospace Maintenance, Repair and Overhaul (MRO) into line with Industry 4.0 manufacturing techniques taking hold of the sector.

An innovative Aircraft Maintenance Repair & Overhaul Configuration Capture System (AMROCCS) is being developed and trialed at the AMRC that could transform the way aerospace companies maintain fleets of aircraft.

The consortium aims to develop a system that will provide huge time and cost savings alongside more effective control and management of MRO processes; through collaboration with a wide variety of partners working across different industries all using the latest technologies in 3D capture, gaming, augmented reality visualisation and wearable technology.

Along with Argenta, the AMRC, Intoware Software Ltd, Advanced Aerospace Assembly Ltd, NCTech Imaging Ltd and Serious Games International Ltd make up the consortium which is joined by strategic partners such as BAE Systems,

Marshall ADG, Siemens and Autodesk.

Argenta Commercial Director, Mike Drummond, said: "To keep aircraft flying safely throughout their serviceable life, high quality MRO is vital.

"The design and manufacture of aircraft is increasingly being performed through digital manufacturing methods such as CAD modelling and robotic assembly – yet MRO operations remain largely paper-based."

"We are addressing this by analysing the requirements of our industry partners and using those to directly develop a system that will reduce the turnaround time of MRO processes while providing improved real-time record keeping and right-first-time rates.

"Part of the benefits of working in a consortium is that we have worked together to identify the end users and use-cases for the technology so we know it will be industry-ready," he added.

AMROCCS is a paperless maintenance system that gets real-time data to engineers undertaking MRO. The system uses automated 3D and scanning data capture using wearable and handheld technologies to deliver diagnostics and customisable workflow

instructions bespoke to each task. The results are then recorded and the audit trail is updated for access either on, or off aircraft.

The system aids the engineer in not only diagnosing and repairing any fault, but gives engineers real-time access to on-line expert consultancy and training.

Theme Lead for Digital Manufacturing and Augmented Reality Technical Fellow for the AMRC's Integrated Manufacturing Group, Chris Freeman is leading the AMRC's involvement in the AMROCCS consortium. He said: "AMROCCS is about utilising new and innovative technologies to bring MRO processes into line with Industry 4.0 practices.

"These practices offer more process visibility and traceability making repairs safer, more auditable, with the ability to see patterns in component repairs to aid preventative maintenance and reducing non-productive man hours to deliver aircraft back into service faster, cheaper and safer.

Companies who are interested in AMROCCS are encouraged to contact Mike Drummond for a demonstration of the technology at mike@argenta-europ.com



Engineers at the AMRC's flagship robotics and automation facility, Factory 2050, are on a mission to build their own Caterham sports car

The team at the Integrated Manufacturing Group (IMG) are using easy-to-deploy, advanced technologies that even the smallest of businesses could use in assembly.

The car will be the centre piece of a 'reconfigurable assembly integrated demonstrator' – dubbed Project RAID – that will be one of IMG's showcase research cells demonstrating how these advanced technologies can be used to fuel improvements in manufacturing productivity.

The project will show manufacturers from any sector how data-powered Industry 4.0 technologies and techniques can be tailored to any complex full assembly process with a short lead time.

IMG's engineers are utilising a variety of technologies covering all the themes of research currently underway in Factory 2050; robotics, automation and control, integrated metrology, digitally assisted assembly, manufacturing informatics

and visualisation of data.

IMG Operations Manager, Chris Greaves said: "We are using Project RAID to demonstrate that there are accessible and cost effective ways for any manufacturer, including small and medium sized enterprises (SMEs) within the automotive supply chain, to utilise the data they are potentially already collecting to optimise their high-variation assembly of high-value, low-volume products.

"Our engineers are assembling half the car by hand as per Caterham's written instructions, then we will build the other half employing a variety of advanced manufacturing technologies, collecting data about the various construction processes along the way.

"That data will be used to validate this second phase of construction and run discrete event simulation (DES) and find out how effective our assembly processes are, either by hand, using smart tooling or robotic

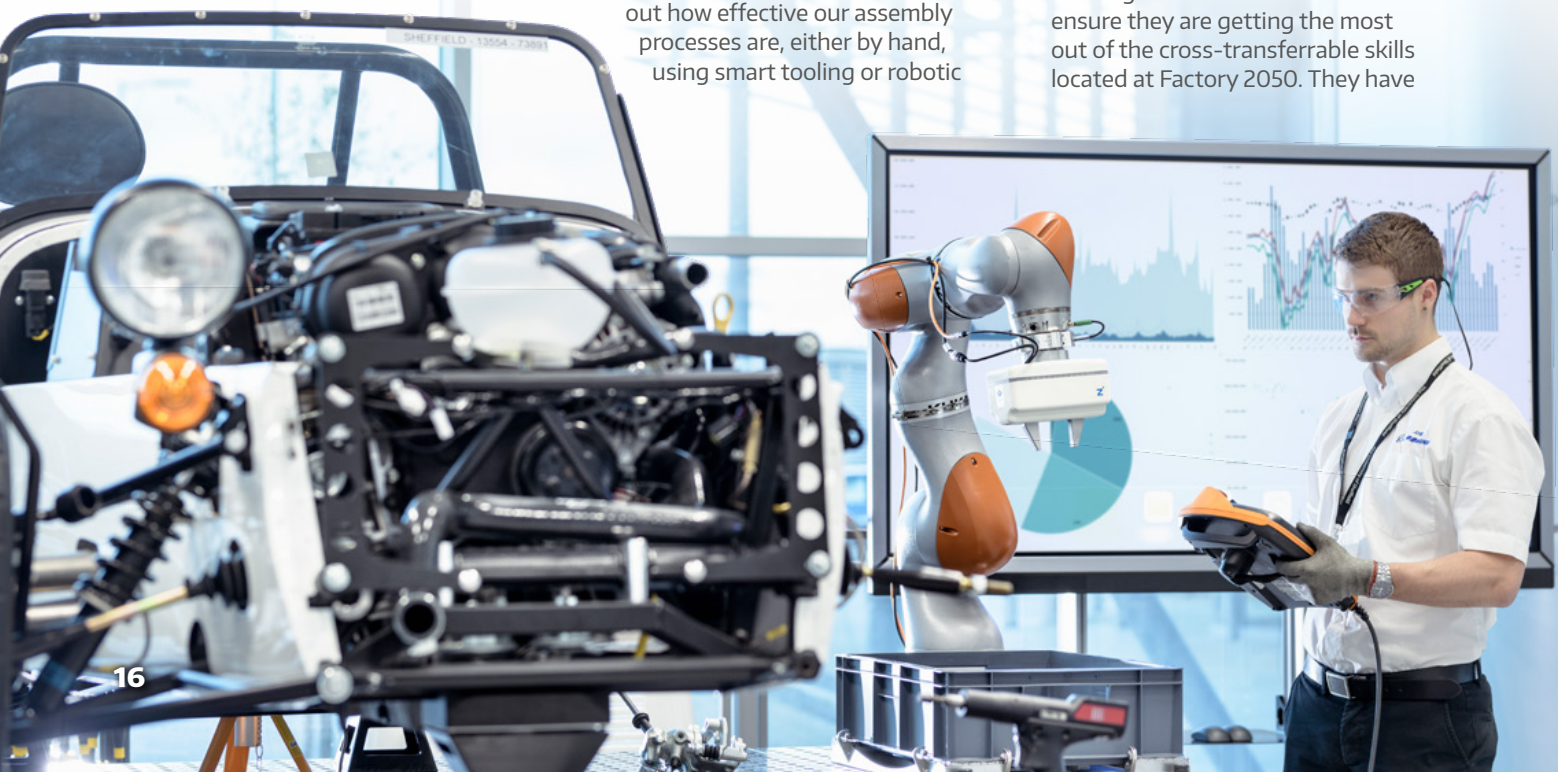
assembly."

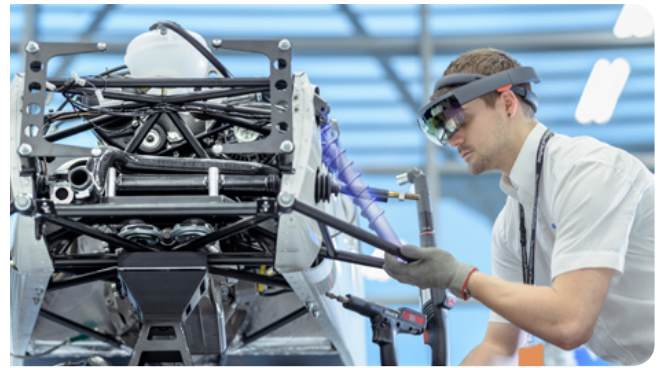
IMG want demonstrate that the utilisation of these technologies is not just the preserve of big business, but is the key to optimising production processes for everyone.

Project Manager Alex Godbehere, said: "The technologies that we have implemented are easy to integrate and cost-effective enough to be of use to SMEs, but powerful enough to drive the Industry 4.0 manufacturing techniques and processes that are driving UK manufacturing productivity today."

"This project will support the growth of the automotive supply chain within Sheffield City Region, enabling SMEs to take advantage of the new opportunities and methods in which to engage with OEMs and Tier 1 and 2 manufacturers," he added.

The engineers at IMG are keen to ensure they are getting the most out of the cross-transferrable skills located at Factory 2050. They have





assembled a team from across their engineering disciplines, including mechanical, electrical, robotics and digital; to evaluate what technologies involved in the assembly of complex components should be integrated to the demonstrator.

These technologies include the development of a new generation of hands-free digital work instructions, suitable for use with a wide variety of dynamic and responsive technologies.

The team will explore new avenues such as developing digital work instructions so operators can receive assistance that provides real-time data with geographic memory; for more responsive knowledge sharing that will be right-first-time in the field and provide endless possibilities for on the job, peer-to-peer learning for new or complex assemblies.

“Using adaptable, modular smart fixturing which can be easily updated for new assemblies and products, will bring flexibility to manufacturing processes,” said Godbehere.

“We are using self-verifying smart fixturing to streamline manufacturing processes and safe-guard quality control. By being calibrated to measure the weight of each part added to an assembly, we can monitor overall weight of assembly and be sure we are assembling the components in the right order.”

Reconfigurable smart-fixturing will also be used to simplify assembly processes, ensuring correct selection of parts and preventing components being assembled in the wrong order.

The team want to help manufacturers overcome the barriers to adoption for some digital technologies, such

as collaborative robotics systems, or ‘cobots’ by demonstrating them in a meaningful way during assembly.

Cobots can be used without fences or barriers so are perfect for assisting with complex or time consuming tasks such as positioning of components or gear meshing and cog alignment, the team are tackling issues with portability and power connections to support with integration.

The use of intelligent kitting, or reconfigurable shelving is being trialled whilst assembling the Caterham. IMG has implemented a LED ‘pick by light’ system, powered by a manufacturing execution system (MES) which tracks and highlights component locations. This system can be used by more than one operative at any one time, saving valuable shop floor space and can be reconfigured for any new assembly quickly for quick turnaround; supporting flexible manufacturing spaces.

Critical for the success of the project is the collection of data and the development of the assembly cell’s digital twin which underpins the whole manufacturing process.

Full Stack Developer Jonathan Eyre is working on the digital aspects of the project and said the aim of utilising the data collected is to rid processes of non-value added time.

“Data is powering the manufacturing execution systems (MES) to monitor work-in-process and improve productivity. We are using a digital twin to analyse operator procedures to reduce preparation time and non-value added procedures.”

By utilising preventative maintenance strategies the system will signify non-conforming behaviour for prediction

of wear and tear, allowing prescriptive maintenance rather than reacting after a failure has occurred.

“Even legacy machines can be retrofitted with low-cost sensors to track equipment utilisation and operation,” added Eyre. “This allows more visibility to managers of the workshop floor via data collection so they can plan and manage equipment down-time more effectively and at lower-cost.

“In addition, utilisation information allows business cases to be formed with actual statistics rather than just investing in new equipment because they think it is necessary.

“We want to show smaller companies what ‘enough’ information is for them and how they can use what they already have available, or how they can implement a low-cost sensing system for asset utilisation to optimise their manufacturing planning for improved productivity.”

Greaves said: “We are looking past the data itself to create viable business cases to showcase to SMEs how they too can improve their manufacturing productivity. Tier 1 and 2 suppliers are continually looking for more visibility and traceability of the products they procure to optimise their supply chain processes, if you don’t utilise the data, another company will – potentially making them more competitive.

“Some SMEs are already connecting their facilities digitally, providing traceability, extensive auditing and cohesive vertical and horizontal integrated working options; so get on board now, when it comes to data, the message is definitely use it or lose it!”





MTA and AMRC Factory 2050 partner to showcase Industry 4.0 technologies at MACH 2018

Low cost automation can revolutionise SMEs businesses

The Manufacturing Technologies Association and the AMRC have partnered to put together a unique feature to demonstrate cost effective adaption of Industry 4.0 Technologies at MACH 2018.

MACH 2018 is the place to discover new technologies that shape the world we live in. The AMRC's Factory 2050 is the UK's first state-of-the-art factory entirely dedicated to conducting collaborative research into digital assembly and flexible component manufacturing.

The two are staging a joint showcase of cost effective solutions for the adaption and integration of Industry 4.0 technologies into SME manufacturing businesses.

Recent figures - from the Made Smarter

Review - found that the positive impact on UK manufacturing of faster innovation and adoption of industrial digitalisation technologies could be as much as £455bn over the next decade.

James Selka, CEO of the MTA, said of the project: "Like the AMRC, we at the MTA understand that it is vital to cut through some of the jargon and hyperbole around Industry 4.0 and show first-hand the practical advantages Big Data can bring to an SME business."

"In the light of the publication of the Government's Industrial Digitalisation Review - 'Made Smarter' we must demonstrate to British industry the benefits this technology can bring to their businesses. It is our job to bridge the gap between industry and academia and MACH 2018 is exactly the platform

to do this."

The overriding theme running through MACH 2018 is interconnected technology and the future of manufacturing.

The AMRC's Head of Digital, Dr Rab Scott, said: "The MTA's MACH exhibition gives the AMRC a great opportunity to demonstrate that the adoption of digital technologies can be achieved at low cost and that the impact on businesses can be transformational.

"This project is a prime example of the work that the AMRC does nationally with manufacturing SMEs. On the stand, we will also be demonstrating what the future of assembly and manufacturing could look like, showing what the value of these technologies could be."





Looking at Made Smarter in Sheffield

A few weeks before the publication of his Industrial Digitalisation Review, Juergen Maier came to The University of Sheffield to open the Mindsphere Lounge: not some futuristic backdrop to a scene starring Ryan Gosling and Harrison Ford, but a cutting edge, cloud based operating system that allows manufacturers to harness big data from billions of intelligent devices, to unlock transformational insights across their businesses.

During the opening of the new facility, the CEO of Siemens told his audience that Sheffield – think Bessemer, Stainless Steel and Siemens' own Open Hearth process – had been home to the first and second Industrial Revolutions, and now it would lead the Fourth.

By that he meant a digital revolution: a revolution founded on technologies such as virtual reality and augmented reality; on robots and cobots; on artificial intelligence, machine learning and blockchain; on harnessing data and using it to better organise and manage assets and processes; and on the Internet of Things.

He said the same thing privately when he came up to the AMRC later that day to talk to the collaborative research teams running a number of projects in which Siemens' technology is key to making big breakthroughs in the manufacture of aerospace components. As he moved from project cell to cell, his eyes would light up at each new application and innovation. At one point he remarked: "We're here aren't we, we are doing this."

What he meant was that the AMRC – and other members of the High Value Manufacturing Catapult – are blazing the trail for digital manufacturing: de-risking what can sometimes seem far-fetched technologies such as the creation of digital twins, or machines that can learn. And, in de-risking them, accelerating their industrial adoption.

His report, Made Smarter, published close to All Hallows Eve, may have made Treasury officials' blood curdle, but it was a clarion call to politicians, industrialists and academics: get this right and we can rebalance our economy; bridge the divide between the north and the south; create new sources of wealth that are more fairly shared among those who have helped make it; and inspire a new generation of engineers with the prospect of highly skilled, high value jobs that transform society for the good.

As an entrepreneur and a manufacturer, Juergen knows that the success of the Fourth Industrial Revolution will require inspired leadership. It will also require a willingness to adopt technologies that can seem more like science fiction

than science fact; and a passion for transforming innovative ideas into technologies to drive big gains productivity.

If Juergen's prognosis is correct, failure to adopt these technologies will lead to long term industrial decline. The AMRC is committed to providing the leadership, innovation and support for early adoption that are crucial to making the Fourth Industrial Revolution a success.

The AMRC is doing this across the North, from a soon-to-open AMRC in the North West and North Wales (the latter supported wholeheartedly by the Welsh Government); and an emerging institution near Glasgow which draws inspiration from the AMRC in Sheffield, and support from the Scottish government.

Like them, we share Made Smarter's positive vision for advanced manufacturing. And we are working with him to make good his dream that the North – with the Sheffield City Region centre stage – becomes the engine room of innovation that will drive the Fourth Industrial Revolution.



GETTING THE CHALLENGE RIGHT

With the publication of the Industrial Strategy White Paper in November, the Prime Minister heralded a 'new approach to how government and business can work together to shape a stronger, fairer economy.' But what will it mean for smaller businesses?

Footprint Tools have been making hand tools in Sheffield since the 1870s. At its peak, the family-owned company employed 350 people. But the death of the coal industry and the rise of globalisation leading to cheaper Far Eastern products exacted a heavy toll. Today they employ just a dozen people.

Determined to grow the business, keep skills in Sheffield, and improve

productivity, the owners turned to the AMRC to help them understand and exploit the benefits digitalisation might bring to their operations. The result is an unimagined move towards robotics, which could keep product lines in Sheffield, rather than outsourcing to China, and free skilled workers from repetitive and arduous work to perform higher value activities.

"We knew very little about the Fourth

Industrial Revolution (IR4) before we engaged with the AMRC," says Richard Jewitt, who has taken over the day-to-day running of the business from his father Christopher. "The ability to see real live demonstrators (therefore de-risking our potential investment), and to work alongside highly skilled robotics engineers, has opened our eyes to the potential benefits digitisation could bring a small business like ours.



It's great to have an ambition to be world leading in artificial intelligence, biomedicine and driverless cars. But if the Prime Minister is to achieve her objectives of sharing wealth and prosperity, the Industrial Strategy needs to not only create an elite group of industrial world champions, but raise the performance of the hundreds and thousands of smaller and medium sized firms who are the backbone of the British economy.

James Selka, CEO of Manufacturing Technologies Association



But we need support to get this technology on the shop floor. We had hoped the White Paper would address this urgent need to help firms like us make the most of IR4 technologies like robotics and automation."

In the weeks since its publication, others in industry are drawing similar conclusions. "It's great to have an ambition to be world leading in artificial intelligence, biomedicine and driverless cars," says James Selka, CEO of Manufacturing Technologies Association (MTA). "But if the Prime Minister is to achieve her objectives of sharing wealth and prosperity, the Industrial Strategy needs to not only create an elite group of industrial world champions, but raise the performance of the hundreds and thousands of smaller and medium sized firms (SMEs) who are the backbone of the British economy."

He said he was disappointed that the Industrial Strategy did not endorse the policy prescriptions of the Made Smarter review, but was more general in welcoming it and looking to "a review of what actions are most effective to improve the productivity of SMEs, including how to address the long tail of less productive businesses."

Like many who had worked on Made Smarter, Selka found this a little frustrating. "A few weeks before the White Paper we had the publication of the independent Industrial Digitalisation Review – Made Smarter. That document addressed these very issues."

He said he and many of those he speaks to in industry are disappointed that the Industrial Strategy did not explicitly engage with the recommendations of the Made Smarter review. "Many of us believe that Made Smarter gave us a clear narrative of how to overcome the obstacles to the uptake of transformative digital technologies," said Selka, who contrasted the government's approach to that of Germany, where Industrie 4.0 is big news and its uptake was written into the last German Coalition Agreement.

Unlike Germany, he says, we have no national brand for the Fourth Industrial Revolution to showcase and demonstrate best practice and the opportunities that digitalisation – from Augmented and Virtual Reality, Digital Twins, Robotics and Automation, through to Big Data, Cloud and Edge Analytics – offers a broad spectrum of UK manufacturing firms.

Selka believes Made Smarter could still be that brand. This year, the MTA has joined forces with the AMRC to make MACH 2018 an international showcase for cost effective digital applications for adaptation and integration into SME manufacturing businesses. "MACH 2018 will be inspiring, but I fear that if we don't get the digital narrative right – and connect it to real world solutions – the UK economy will continue to fall behind. Recent surveys show just how little UK industry understands what the Fourth Industrial Revolution is all

about. They know it will affect them, but they have no idea of how to exploit the technologies to improve their own performance."

At the AMRC's recent Factory 2050 conference (see page 24), Selka said that Britain was "failing to inspire young people who are often digital enthusiasts" but, more importantly, we were "failing to inspire industry" and that has a negative impact on skills as young people will not be attracted to train for high-value, digital industry jobs.

"SMEs find it harder to finance capital expenditure; they often lack the skills to build an investment case for technology which doesn't (yet) have a proven track record of return; and many of the tried and tested methods that SMEs rely on like Asset Finance struggle to support digital assets," he said, in comment that resonated with Richard Jewitt.

"We applaud the Prime Minister in wanting to rebalance the economy and to heal the divide between the north and south," said Jewitt. "But the grand challenges in the Industrial Strategy are just too grand for companies like ours. Our ambition is to be more productive, to secure jobs and skills in a company that has been in Sheffield for 150 years: to do that we need practical advice and support now for adopting existing digital technologies. Dreams of driverless vehicles and artificial intelligence are just that to us: dreams."



Bart fulfils a driving ambition

After 16-plus years as Chairman of the AMRC with Boeing, Bart Moenster officially retired from the role at last month's main board meeting. Bart has been the staunchest ally of the AMRC and has cemented the special relationship between Sheffield and Boeing.

When Bart Moenster flew to England in the late 1990s to "see some company called Airbus and another called Rolls-Royce" he found time in his busy schedule to meet a "fella from Sheffield" for a round of golf. Nothing strange about that. After all, many a business deal is struck on the links: except that Bart, Director of Manufacturing Technology for Boeing, didn't play golf.

"Our London office told me there was some guy from Sheffield called Adrian Allen who wanted to see me," says Bart. Allen, then the chain-smoking sales director of rotary cutting tools firm, Technicut, was a man on a mission. He had already been to St Louis and made contact with Boeing. Now he wanted to meet Bart. First, to sell Boeing a new tool developed by the family-run firm. And second, to get the aerospace giant to sign up as a strategic partner to what he was then calling the South Yorkshire Centre of Excellence for manufacturing (SYCoE).

Flying to Belfast, Bart figured he could at least enjoy the wonderful views as he clipped balls into the long grass around the Royal Portrush Golf Club, while Allen regaled him with talk of his new centre in Sheffield. Always on the look-out for clever people and smart technologies as he travelled the world for a company hungry to learn from others, Bart was sufficiently intrigued that he agreed to meet Allen a few days later. This time in Bristol, without the clubs.

Allen brought two secret weapons with him. A "proposals writing machine" in the shape of University of Sheffield Professor, Keith Ridgway, and John Baragwanath, from Government Office. Bart liked what he heard. "Normally we wouldn't work with a university, because universities are famous for what they call playing in the sand box. They do a project; they write a report; and it goes on a shelf and never gets looked at again. But what these fellas were talking about was very different."

The American told them he had worked with a consortium in the US and suggested they use it as a governance model. "I gave Keith some papers as to how the other consortium worked – it had a tiered membership with Tier One members paying sufficient money to sit on the board, enabling them to direct the centre's work. That is where this concept of the AMRC came from – a consortium based on three legs – academia, industry, and government. By setting the membership price sufficiently high, you secure skin in the game: you know your members have an interest in making R&D work," Bart said.

Within months of their first meeting, Allen's SYCoE had morphed into a successful bid for £15m of funding from



Back at the club house



Tee-off

At the cutting edge of a new era



High hopes for hi-tech take-off
The Star Business, Wednesday, February 5, 2014
Delight at £15m Boeing research centre plan

Take-off for jobs
Aerospace centre joy

We land Boeing!

Boeing 'planning university tie-up'



University leads way in £15m Boeing coup

Making headlines

the UK government and £7m from the South Yorkshire region and the AMRC with Boeing was born.

"When we started out it was all machining. Although we had a fee paying structure a lot of the early members came in with in-kind payments – machines donated to us in lieu of dues. But as our reputation grew we were able to say no – just give us your machine and pay your dues. Pretty soon our shop floor was a showroom for competing machine tool companies who wanted to show off their very latest kit." Having this state-of-the-art machinery has proved vital to the success of the AMRC. "The combination of smart people and smart technology has enabled us remove much of the risk that inhibits technology transfer. By proving-out innovations in a shop that has real machine tools using the latest technologies making real parts in real time, we give shop managers the confidence that there will be no hiccups;

they know the technology will work on their lines," says Bart.

One of the early projects was to develop a faster way of machining titanium trailing edge flaps for the new C-17 aircraft, replacing the old aluminium flaps. Production times were made five times faster and 80 per cent cheaper – unheard of productivity gains that were to become the hallmark of the AMRC.

The news spread. Before long, Rolls-Royce and BAE Systems were knocking on the door. Since then, Bart says the growth of the AMRC has been crazy, reaching more than 100 partners today. "And that is all down to these crazy characters - Keith, Adrian and John, who know no bounds."

Looking back to that first meeting at Royal Portrush, Bart can't help but feel he made the right decision. "We got the model right," says Bart, who went on to develop similar centres around the world. One such was at Cranfield.

"They asked me if Chris Ridgway (Office Manager of the AMRC and wife to Professor Keith Ridgway) would be the director – I don't know whether they knew who Chris was, but they were right to think that she is director level material," he chuckles.

In retirement he will carry on his volunteer art and history museum work, see much more of his grandchildren, and is even taking up golf – just in case Allen drops by for a round on a flying visit to the Portland, Oregon AMRC. But the time has long since passed for the former Technicut salesman to sell him that cutting tool. Instead, he will have to settle for a brand new Boeing Sheffield factory in his back yard: an eagle if ever there was one.



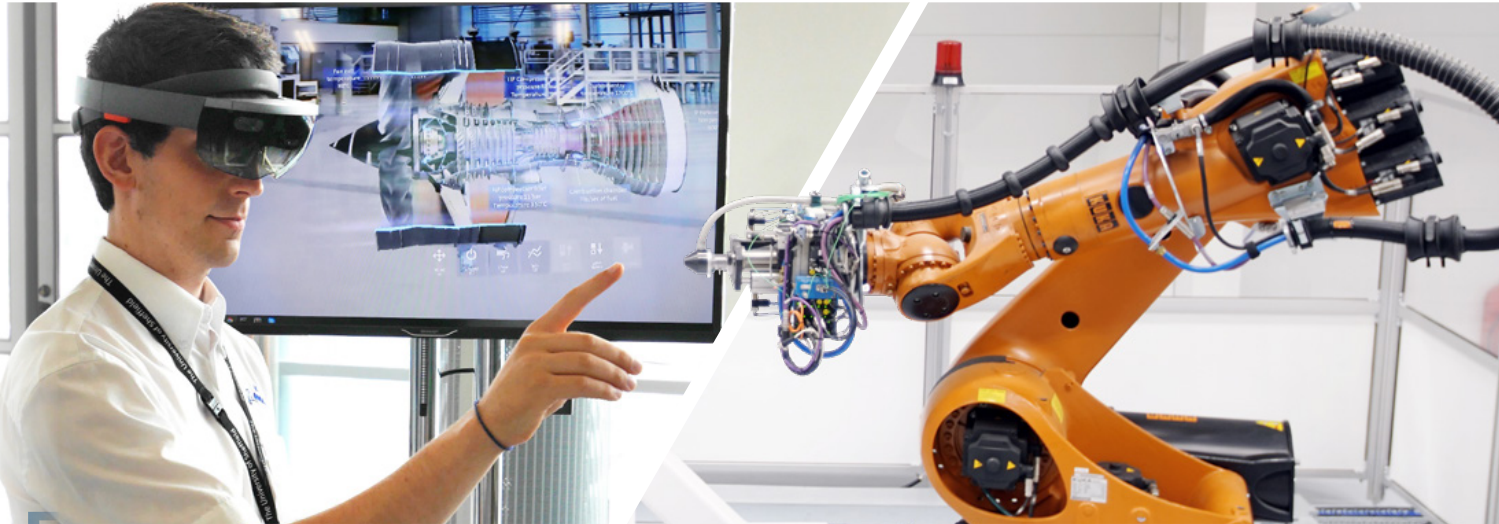
All smiles after the recent Boeing groundbreaking



Bart at the cutting edge



AMRC FACTORY 2050 CONFERENCE



WHERE DIGITAL MEETS MANUFACTURING

Professor Keith Ridgway opened the 2017 Factory 2050 conference by reminding his audience of the aims of those who founded the Sheffield Technical School – the C19th forerunner of today’s University. These were that the ‘highest education’ should be ‘within the reach of the child of the working man’ and that it should help local industry, improve health, raise the competitive position of the city and ‘assist the nation in its trade competition.’

These ambitions, he said, had not changed. Today, the AMRC, which is literally built on the ruins of the First Industrial Revolution powered by coal and steam, is devising new ways of connecting young people from working class areas of the city to the ‘highest education’ – degree qualifications in engineering at a Russell Group University that stands second only to Imperial College London for its research income.

And then he told the conference how the AMRC is harnessing the talents of engineering graduates and postgraduates to drive unheard of gains in productivity: how halving the value

added time, doubling the productivity at zero consumable cost difference, and achieving 6-sigma process capability for Rolls-Royce, helped secure £200 million plus investment in a new manufacturing plant in the North East of England making fan discs for passenger jet aircraft.

But he said the Fourth Industrial Revolution, which this conference was all about, will be built on the power of data. Astonishing levels of computational power and connectivity, especially new low-power wide-area networks, combined with the emergence of analytics and business intelligence capabilities, is opening up a



Professor Keith Ridgway, CBE:
Executive Dean of the AMRC Group.

brave new world for manufacturing, he said. Elements of this revolution could be seen all around Factory 2050, from augmented reality applications through to robotics and smart workbenches.

The challenge now, he said, was to ensure that these applications and opportunities are made available to, and adopted by, the UK’s many underperforming companies and not just the few high performing, global leaders.



A road map to DIGITAL SUCCESS



Listening to Paul Haimes 2050 keynote address about the potential pitfalls that ill-equipped manufacturers may face when venturing out into the fast moving world of industrial digitalisation, it was easy to see why some companies choose a stay-at-home-approach in the hope that the winds of change will subside and business return to 'normal'.

Haimes is Vice President of Pre-Sales at PTC, the US \$1.4 billion software company headquartered in the USA. His breezy tour de force was at once exhilarating and cautionary. When talking of the global economic potential that digitalisation holds, the numbers he cited were in the hundreds of trillions of dollars. But big prize money can come at the expense of deflated expectations. A recent survey, he said, shows a significant and widening gap between the value organisations expect from digital transformation and the sometimes disappointing reality.

The top pitfalls to success, he said, are that investments are often spread too thin: firms have great ideas of what digitalisation could do, but they don't prioritise or invest smartly. And this is because too many firms lack clarity about the source of profits. He also identified the use of traditional waterfall models as being a weakness. So how do you succeed?

"I believe business needs three key things," Haimes said. "First you need a clear strategy which includes people, process and technology – with sponsorship from senior management. Then you need to understand how the Internet of Things (IoT) is going to add value – through a series of prioritised use-cases, including how it will make money. Finally, you must have a roadmap for transformation, starting with a proof of concept and a route to scalability."

He then cited the case of an engineering consultancy that missed out some of these critical ingredients: "In many ways this is an all too familiar story. The company wanted to connect their engine test cells to give remote visibility to the operators and managers during long test cycles.

"As with many IoT projects this one was given to the IT department to investigate the technology, but without any prior linkage to what the business was trying to achieve. There was no prioritisation of use-cases – no thought to how they could benefit the business. And no plan to scale throughout the business."

The outcome was a successful proof of concept, which was done quickly and delivered on expectations, but it was then down to the IT organisation to sell IoT internally. They've developed a number of other use-cases, so it's making progress, but it's slow and there's no scalable deployment in sight.

"So, what did we learn here? It's critical to involve and align senior stakeholders in the business and agree on what IoT is going to deliver before start any form of technology investigation," he said.

He then talked about a much smaller company employing 30 people, based in Ireland, making process equipment for powder handling. They started their IoT journey three years ago and developed their own roadmap and benefits based on researching the market and selecting the most appropriate platform.

"They successfully executed a proof of concept on a range of blenders which,

though largely successful, highlighted a few problems with the scalability of the platform. They changed to an alternative platform before the production roll-out and the project has gone from strength to strength," he told the conference.

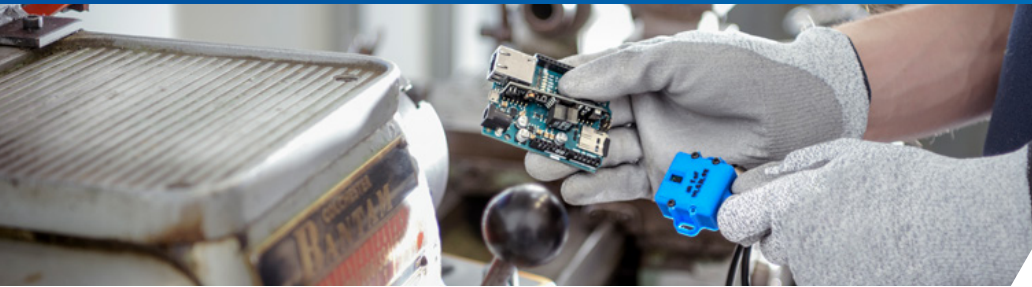
"They were the first to offer their customers IoT dashboards showing the real-time performance of their products – and as their product controlled material quantities, it gave their customers real insight into line performance. The next phase of their roll-out is to offer their product as a service – charging by quantity of material, not the product itself – ensuring regular and recurring revenues.

"This is a great example of what can be achieved by a small company with a vision for the future, a bit of careful planning and an acceptance that you might not get it right first time, but better to get started than be caught napping," Haimes said.

So, with all this in mind, what would he recommend as the first steps to get started?

"First of all, do your homework – there's a huge amount of material available. My advice would be to stick to the main analysts and management consultant groups – they have the depth and breadth of resources needed to understand the market and the technologies. But remember, business discussions need to take place long before anyone gets their hands on a sensor or starts playing with analytics algorithms."





A legacy worth investing in.



Leadership and fast adoption

Sam Turner: Chief Technology Officer at the High Value Manufacturing Catapult.

The former AMRC CTO made a passionate plea to policy makers who might think that the UK's manufacturing days were over. Far from it, he said. As the world's eighth largest manufacturing nation, manufacturing accounts for 50 per cent of our exports, employs 2.6 million people and accounts for 70 per cent of business research and development.

But there are challenges. Chiefly productivity. He told the conference, how workers in France, Germany, and

the USA produce as much in four days as we produce in five. Automation and robotics, he added, could transform that. But, right now, the UK lags behind the likes of Germany the US and Japan in the adoption of these technologies.

The market, he argued, was failing. There was a distinct lack of financial vehicles for small businesses to adopt technology; there was too much short-termism; industry leadership was risk averse; and an ageing workforce with limited capacity for change, were all hurdles to be overcome.

Doing nothing, however, was not an option, he said. That way, lay a loss of competitiveness, reduced market share, even lower productivity, increased offshoring, and the rapid erosion of the UK's small and medium sized companies, and the loss of economic resilience.

The answer? Industrial digitalisation – the transformation of how we engineer, make, distribute and operate products. But that, he said, requires leadership, the fast adoption of new technologies, and increased investment in innovation and ideas.

Overcoming barriers to adoption



James Selka: Chief Executive of the Manufacturing Technologies Association.

So what are the barriers to industrial digitalisation? James cited surveys showing that just eight per cent of UK manufacturing companies understand Industry 4.0. Almost 60 per cent of manufacturers, by contrast, think that digitalisation will impact them and their business. If we compare this with Germany, James says we have reason to be worried. 46 per cent of German firms use Industrial Revolution 4.0 (IR4) technologies already, while another one per cent are getting ready to implement.

Unlike in the UK, digitalisation is a big news story in Germany. In Britain, by contrast, when it does feature in the news it is often a story about how robots will be stealing jobs.

James agreed with Sam that there is a real lack of leadership. There is also no clear narrative of what IR4 means. James said that while "there is plenty of expertise in companies, academia and institutions like the Catapults" this expertise "is fragmented with no focus or coordination". As a result: "the UK has no national brand for digitalisation."

For James the barriers to adoption are greater for smaller firms. "SMEs find it harder to finance capital expenditure," he said. "Often they lack the skills to build an investment case for spending on technology which might not have a proven track record of return."

Some tried and tested methods that SMEs rely on like Asset Finance "struggle to support digital assets." In addition, SMEs are more likely to worry the risks to their business from the lack of security. In short, he said, "we don't yet have an idea of what good looks like."



A more profitable reality for powder processing

When the UK division of the Hosokawa Micron Group looked to improve its productivity, the route the innovative powder processing company chose was to couple its market leading equipment and services to the world of virtual and augmented reality (VR and AR), and then to harness this to data analytics.

The result has been to transform a business that had appeared to plateau in terms of revenue and growth to one with a target operating income rarely seen in the industry.

"We looked at our digital strategy across the business both horizontally and vertically and when we were looking at the horizontal one, one of the things we wanted to know is could we use VR rather than building a wooden mock-up of our containment systems when selling to clients," said Iain Crosley,

Hosokawa Micron Ltd's (HML) Managing Director. "We talked to the AMRC and they sent their people over to see us and help develop a solution."

Using VR to show the product to potential customers proved very successful. The first piece of equipment the firm sold this way turned out to be the biggest isolator they had ever built: 14 chambers using hydrogen peroxide and high temperature sterilisation.

"It was also the first sterile isolator we had done," says Crosley.

Having been an early adopter of data analytics, he then wondered whether there was a way of bringing the virtual and data analytic technologies together in a way that would drive improvements in performance: in particular, process and lab efficiencies; increased plant uptime; reduced operator error; improved product quality; and faster

changeover and preparation processes. To achieve this, Crosley had to overcome a number of barriers. These included:

- Islands of disparate data
- Lack of equipment condition and state visibility
- Lack of time due to firefighting resource limitations
- Lack of data analysis capability
- Lack of automated processes
- Excessive reactive and emergency work
- Lack of instrumentation and sensors
- Production demands limit operational flexibility

To help him overcome these challenges, Crosley had an ace up his sleeve in the form of Xpert Rule. With their help,

[continues on next page...](#)



continued...

Hosokawa now has a mobile phone app that allows for the remote monitoring of the company's contract powder processing suite. **The result is an end-user interface that enables:**

- Effective monitoring of equipment and processes – alerting operators to problems before they occur with anomaly detection and predictive analytics
- Capture and automate best practice domain expertise of the workforce and enhance with machine learning
- Deployment of intelligent automation to the IoT Edge, running on the smallest embedded computers e.g. Raspberry Pi

In addition to the mobile app, Crosley has also worked with the AMRC to develop a powder processing digital twin. Although still in its infancy, the company recently took this to the PowTech event at Nuremberg where it attracted huge interest. "It is the first digital twin in the powder processing industry," says Crosley. While not all his customers will use it, he believes this technology has tremendous potential. Many of his customers are in remote parts of the world and the twin will allow his team to more effectively identify the service and maintenance requirements of equipment in distant place. The digital twin could also be used in plant commissioning.

The big obstacle to achieving this has been the lack of knowledge inside the organisation. "We are processing engineers and the creation of a digital twin requires a lot of gaming visualisation knowledge behind it – and we don't have that," said Crosley. "So, having people who understand the technologies and who can put them together to give the best immersive experience but also get the highest functionality has been great, and that is the kind of thing we get from the AMRC."

The benefits of digitalisation have been both measurable and impressive:

- Connected machines sharing data in real time to maximise efficiency across the suite
- Continual monitoring of key equipment parameters to ensure all control actions are based on actual process data and verified process models with pre-set limits
- Combined rules from data and experts to detect process or equipment problems before initiating appropriate actions, from notifications and alarms, to advice and fully closed-loop solutions
- Operational data now integrated throughout the business processes
- The deeper understanding of our processes enables leaner management of our supply chain
- Complaints due to out-of-spec material minimised: 98 per cent right first time
- Customer retention and growth: now have closer control of business/product mix to combine the higher volume, lower margin with specialised lower volume, higher margin work

The application of these smart factory initiatives has underpinned the business case for an investment of £1m in Hosokawa's contract manufacturing suite over the next three years. In addition, it has given the company confidence that its contract manufacturing revenues and margin will develop strongly over the next three to five years.

In FY2016 – three years after installing data loggers and beginning this journey – Contract Manufacturing Sales had grown by 34 per cent. The mid-term plan for 2017-2020 is confidently targeting a further 36 per cent growth. The process areas are effectively land locked, which means that any improvements have to come through operational efficiency.

The Contract Manufacturing side of the business delivers a higher gross margin than machine sales and will be a key contributor to its target operating income of eight per cent by 2020; a figure all but unheard of in the industry, where world-class operating income is six per cent.



Remote monitoring of the company's contract powder processing suite



A cut above the rest:

The western world's oldest scissor manufacturer develops sharp new generation of blades after teaming up with AMRC.



William Whiteley & Sons (Sheffield) Ltd, the family owned scissor manufacturer which has been in operation in Sheffield since 1760, has recently teamed up with the AMRC's Design and Prototyping Group (DPG) to create an innovative new state-of-the-art design for their hand-crafted EXO range of scissors.

William Whiteley's, the oldest documented scissor and shear manufacturer in the western world, are world-renown producers of professional and industrial hand-made scissors.

After attending the Advanced Manufacturing Show in Birmingham in 2015, scissor-smiths and company directors Jeremy and Sally Ward (née Whiteley) envisaged a new way to manufacture their scissors, but found to make the improvements was proving cost and labour intensive.

"Due to being a small family-run company, we don't have our own in-house design team. The directors have therefore designed many new products over the years, often with input from our skilled craftsmen," said Jeremy.

"We approached the world-renowned AMRC, which is on our doorstep here

in Sheffield, and with the help of their engineers we were able to develop our ideas and sketches into professional computer aided designs (CAD) ready for production."

The company had ambitious plans to transfer the method of manufacture for their EXO scissors to an investment-casting route, which would give them the required surface finish for their new product.

AMRC Project Engineer Mike Locking said that for a small company to invest in untested designs and new production tooling, it can be an expensive risk:

"Utilising the skills and capabilities we offer ensures designs can be effectively proved out before investing in the equipment needed to upgrade a manufacturing process, minimising the risk.

"We worked with scan data of the

traditional scissors to produce detailed CAD and graphical renderings of the new design and use rapid prototyping technology to prove out the designs before the company invested in expensive new tooling."

Jeremy said: "The assistance of the AMRC has been vital to help us realise the perfect design and ergonomics of the new scissors. They produced 3D printed production-quality prototypes of the handles and blades for us to test. Their input was critical for helping us mitigate the risk of launching a new product."

The company is now celebrating after exceeding an initial target of raising £54,000 through crowdfunding to allow production of this new generation of scissors which are due to start shipping in May 2018.

“ The assistance of the AMRC has been vital to help us realise the perfect design and ergonomics of the new scissors ”

Jeremy Ward



AMRC Forum: Opportunities and challenges in the automotive sector

Under plans to tackle air pollution, the Government has announced that sales of petrol and diesel cars will cease in 2040.



As electric cars currently account for less than one per cent of new sales, a switch to electric will mean significant technological changes for manufacturers, supply chain companies, consumers and infrastructure.

The latest AMRC Forum explored the challenges and opportunities for the automotive sector.

Professor Andy Atkins from Ricardo Innovations plc told delegates focusing innovation on key technologies that will deliver reductions to the environmental and health impacts of transportation will also create opportunities for the automotive industry.

He said the development of electrification and 'battrification' will be a key part of managing the challenges of a rapidly changing industrial landscape; vital for sustainability.

"To achieve this vehicle designs will need to be modified, reducing weight to accommodate the increase in heavier and more complex components of more energy efficient powertrains," Atkins said. "This will create challenges in adoption and availability, but provide opportunities throughout the supply chain."

Tinsley Bridge Ltd. is one SME ahead of the game in taking advantage of the new opportunities in the automotive sector. Driven by an increasing required control of CO₂ emissions and the need to remain competitive, its R&D activity is focused on lightweighting.

Leveraging resources through the AMRC and High Value Manufacturing Catapult, the company has achieved a 40 per cent weight saving engineering a metal composite hybrid truck tube stabiliser.

"Engines become heavier as emission saving technologies are implemented, so designers look for weight savings elsewhere, hence products like ours," said Russell Crow. "Being a small supply chain company we have the flexibility to respond to these new trends; bringing

new or alternative solutions to market quickly."

Dr Stuart McLeod of Jaguar Land Rover told delegates that the development of new automotive technologies will bring about a change in business model which leans towards servitisation.

This new 'on-demand' transport model will drive different ownership and financing options that could dramatically increase vehicle duty cycles, whilst driving a reduction in energy consumption and ultimately changing the way we use, own and rely upon both autonomous and drivable vehicles, and the commodities and materials that are required to manufacture them (e.g. battery materials).

Supply chain companies and OEMs are encouraged to use and share their manufacturing data, connecting their shop floor technology to enable visibility of manufacturing processes and quality of data; creating an Industry 4.0 ecosystem ready for future innovation.

In this ecosystem one of the challenges manufacturers will need to consider is cyber security. McLeod told delegates that getting this right will ensure confidence in the data and encourage adoption of new technologies in the future.

Providers of multi spindle machining centres and automation solutions to the automotive supply chain, SW Machines is already seeing customer trends using connected machining systems.

Reiner Fries said: "Due to the complexity of components and systems, electric vehicles require more parts. To cater to demand, manufacturers will need to increase productivity whilst improving production transparency

throughout the supply chain."

"To do this, the collection and analysis of data is becoming increasingly important and this is available from machining centres, new and old, which can also be retrofitted for longevity."

Chris Freeman of the AMRC said manufacturers need to focus on where they will gain value from collecting and analysing this data; whether it is reducing the cost of core programming and design, improving production systems and processes or safeguarding operations.

"The automotive sector, like aerospace, has many systems designed to manage its supply chain, however very few are integrated. Understanding how to embed these systems into a wider business architecture and using open interfaces to interact with the supply chain will create more value through production transparency."

"This will assist supply chain manufacturers to compete for work more effectively, showcasing their ability to remain competitive whilst servicing a rapidly changing industry."



AMRC Training Centre **Courses**

For further information please contact cpd@amrctraining.co.uk

View all scheduled courses at amrctraining.co.uk/course-calendar

All courses held at the AMRC Training Centre, Rotherham, unless stated otherwise.



January 16th

Fundamentals of Metallurgy

January 17th

Principles of Heat Treatment

January 23rd-24th

Metallurgy for Non Metallurgists

January 31st

**Apprentice Mentoring:
Engineering the Next Generation**

February 12th-15th

Introduction to CNC Milling

February 13th

Carbon & Alloy Steel Metallurgy

February 14th

Stainless Steel Metallurgy

February 19th-22nd

Intermediate CNC Milling Programme

February 22nd

Alloying Elements in Steel

February 28th

**Apprentice Mentoring:
Engineering the Next Generation**

March 13th

Testing Techniques

March 14th

**Understanding Mechanical
Test Data for Metals**

March 14th

Quality & Quality Control

March 19th-22nd

Introduction to CNC Turning

March 20th

Microalloyed Steels

March 26th-29th

Intermediate CNC Turning Programme

March 27th - April 9th

**ILM Level 3 Certificate in Leadership
& Management**

April 10th

**Metals Processing &
Manufacturing Technologies**

May 15th

Non-Ferrous Alloys

May 16th

Combating Corrosion

May 30th

**Apprentice Mentoring:
Engineering the Next Generation**

June 19th

Metallography & Microscopy

June 20th

**Metallurgical Failure Analysis
and Prevention**

June 26th

Steels for the Automotive Industry

MACH 2018 at the NEC Birmingham UK

MACH 2018 is the place to discover new technologies that shape the world we live in. The AMRC and the MTA are jointly showcasing cost effective solutions for the adaption and integration of Industry 4.0 technologies into SME manufacturing businesses. **Visit us on stands H7-340 and H7-540**

Save
the Date
APRIL
9th - 13th

New partners at the AMRC with Boeing



Rexroth Bosch Group

Bosch Rexroth is one of the leading specialists in drive and control technologies. The company supplies tailored solutions for driving, controlling and moving.



Korea Institute of Carbon Convergence Technology is the only government-funded research institute for carbon fibre material and CFRP in Korea.



Horne Cutting Tools. Excellence in technology in grooving, milling, turning broaching, reaming, wear parts, ultra-hard cutting materials.



Assystem design and develop the products and services of tomorrow, building and ensuring the optimum use of their investments throughout the life cycle, coordinating and executing the realisation of their projects and infrastructure.

AMRC Events

April 9th - 13th MACH 2018, NEC Birmingham UK

MACH 2018 is the place to discover new technologies that shape the world we live in. The AMRC and the MTA are jointly showcasing cost effective solutions for the adaption and integration of Industry 4.0 technologies into SME manufacturing businesses.

Visit us on stands H7-340 and H7-540



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