

Digital Twin

On the verge of massive disruption

MACH 2018

AMRC brings Fourth Industrial Revolution to UK's premier advanced manufacturing exhibition.

APPRENTICE AWARDS

AMRC Training Centre announces winner of the fourth annual Apprentice of the Year Awards.

YORKSHIRE WATER

AMRC develops virtual reality prototypes saving Yorkshire Water £1m in design costs.



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Welcome to the

AMRC / Journal

Getting the fundamentals right



One of the great strengths and defining features of the AMRC is the network of collaborative academic research partners we are engaged with across every faculty in the University of Sheffield. Access to fundamental research, in both the physical and the social sciences (management and people being key to the adoption of digital technologies), might seem unrelated to the immediate demands of industry and government for ways to kick-start improvements in productivity, but it is vital to sustainable and inclusive economic growth.

This issue of the Journal has several stories that illustrate the collaborative nature of our research and the way we are addressing the challenges and opportunities of the digital revolution. It shows how our machining group has joined forces with world-leading researchers in the Department of Automatic Control and Systems Engineering on a £10m EPSRC-funded project known as the Future Advanced Metrology Hub. Led by the University of Huddersfield, with partners in Bath and Loughborough, this research is critical to developing the faster and more responsive factories the UK needs if we are to keep pace with competitors around the world who are moving towards the mass customisation of lower-cost products on demand.

Our machining group is also playing a vital role in the pan-European Twin Control project, which is developing a digital twin of the machining process to enable manufacturers to optimise productivity, quality and machine tool performance. This is a highly digital way of dealing with the age-old problem of 'chatter' identified by the likes of Frederick Taylor more than a century ago. The AMRC recently convened a workshop in Sheffield of the 11 European partners to measure progress on a project that is widely seen as integral to securing the long-term future of the UK and European automotive and aerospace sectors.

Both these stories also illustrate how manufacturing is on the cusp of a digital revolution.

For a glimpse of where this revolution is heading, this issue also features an intriguing exchange between Factory 2050 full stack developer, Jonathan Eyre, and Paul Haines of PTC, which adds another dimension to the Twin Control project. Their conversation not only explains the implications of the digital twin for

manufacturing, it also speculates on the potential impact augmented reality wearables could have on all our lives once devices are developed that allow for the seamless streaming of data to the end-user.

Over the last four years the AMRC Training Centre, backed by the Russell Group clout of the University of Sheffield, has trained more than 1,000 young apprentices across the city region. These young engineers of the future are funded by dynamic and forward-thinking manufacturers who understand the value that good, highly motivated talent brings to their business. And now they have the opportunity to move seamlessly from an apprenticeship to a degree apprenticeship; and employers can use the Levy to upskill their older, more experienced engineers in the ways of digital. No surprise, therefore, that this issue should be celebrating the achievements of the latest graduates of our Training Centre and the new Apprentice of the Year; all of whom are carrying the torch for advanced manufacturing.

These three qualities – close collaboration between fundamental and translational research, a commitment to training and educating the engineers of the future in high-level skills for high-value jobs, and a deep understanding of the transformative power of digital technologies – are at the heart of the AMRC's contribution to the regional and the national drive to improve productivity in a way that ensures the benefits of growth are shared by all.

Prof Keith Ridgway, CBE.

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

WHERE DIGITAL MEETS MANUFACTURING



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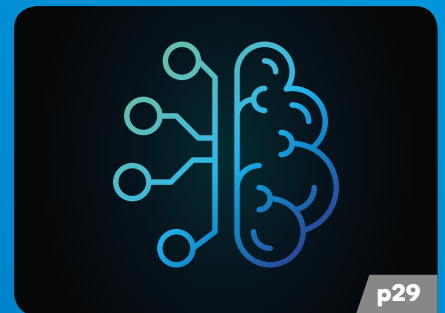
AMRC bring the Fourth Industrial Revolution to the small businesses of the UK at MACH 2018.

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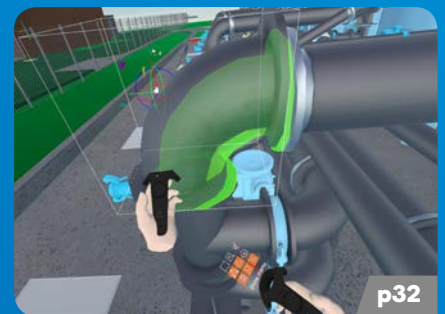
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Efficiency in motion

Airbus and the AMRC are currently investigating the feasibility of autonomous mobile robots (AMRs) for internal logistics within the Airbus plant at Broughton.

The Airbus facility near Chester is one of the UK's largest factories and as such, keeping production lines supplied with tools is a significant challenge. The aim of this project is to develop and demonstrate an AMR to deliver tools within the Broughton plant, allowing staff to concentrate on value-added tasks.

The AMR developed is based on the MiR200 robot from Danish company, Mobile Industrial Robots ApS. The MiR200 has a payload of 200 kg and a top speed of 1.1 m/s (4 km/h). The platform uses laser scanners to map its environment and navigate autonomously between locations, avoiding people and obstacles. This has been enhanced with a rack designed by the AMRC, which was validated using augmented reality during a design review using the Microsoft HoloLens. The racking adds storage for tools, a flashing beacon and direction indicator projector. This has been enhanced with a rack designed by the AMRC, which was validated using augmented reality during a design review using the Microsoft HoloLens. The racking adds storage for tools, a flashing beacon and direction indicator projector. This has been enhanced with a rack designed by the AMRC, which was validated using augmented reality during a design review using the Microsoft HoloLens. The racking adds storage for tools, a flashing beacon and direction indicator projector.

In order to safely deploy the AMR into the complex and dynamic environment at the Broughton plant, extensive testing has been conducted applicable to British Standards with a view to trialling the system. Beyond this initial deployment the AMRC and Airbus are

drawing on research conducted by the Department of Automatic Control and Systems Engineering at the University of Sheffield to establish a highway code for autonomous vehicles working in close proximity with people in factory environments.



MiR200 with racking, integrated flashing beacon and direction indicator projector. (Left to right) Amer Liaqat and Sema Al-Attbi of Airbus UK; Dr Lloyd Tinkler and Dr Scott Dufferwiel of the AMRC.

Mills CNC joins the AMRC as a Tier 1 member and supplies two high-performance Doosan machines as part of the agreement

Mills CNC, the exclusive distributor of Doosan machine tools in the UK and Ireland, has joined the AMRC with Boeing as a Tier 1 member.

As part of the partnership agreement, Mills CNC has supplied a TT1800SY twin-turret/twin-spindle turning centre, and a DNM 6700 vertical machining centre.

Both machines are being used in a major Boeing-initiated research and development programme into the future manufacture of actuator parts and assemblies.

The programme is focused on continuous improvement and best practice with the Doosan machines playing a pivotal role in helping

develop more efficient and effective manufacturing methods.

The intention, following extensive testing and proving out at the AMRC, is to transfer and implement the processes and best-practice manufacturing methods to the Boeing Sheffield factory which is due to open in late 2018.

Kevin Gilbert, Mills CNC's managing director, said:

"These are exciting times for Mills CNC. We're delighted to have become part of the AMRC and to be involved, right from the outset, in such a high-profile and important manufacturing project."

Mills CNC has supplied two Doosan machine tools to the AMRC – a DNM 6700 vertical machining centre (top) and a TT1800SY twin-turret/twin-spindle turning centre (bottom).



65 Year milestone hails growth for Yorkshire engineering firm

The Managing Director of a family-owned precision engineering SME based in Otley, North Leeds, used the company's 65th anniversary to pledge to invest in technology and people in West Yorkshire.

Managing Director of Craftsman Tools Ltd, Robert Johnson, said that continuing investment, together with recent news that UK manufacturing output is at its highest for 10 years, means that the future of the company is looking bright as it looks to expand its worldwide customer base for toolholding, workholding and sub-contract machining.

Founded in 1953 as a tool and cutter grinding company, Craftsman Tools has grown to become one of the country's leading manufacturers of workholding and toolholding products, servicing a broad spectrum of the engineering industry.

One of the keys to success has been the establishment of partnerships with major global companies, from producing a wide range of toolholders for Yamazaki Mazak, collet chucks for Fives Landis, complex parts for oil giant Cameron and being awarded a licence to manufacture and export Coromant Capto® toolholders by Sandvik Coromant in 1998.

Craftsman Tools continues to invest locally in knowledge and training. Its Apprentice School opened in 2013 and won the Manufacturing Technology Association's "Best Training Scheme" Award just one year later; for training undertaken in partnership with the University of Sheffield AMRC Training Centre.

To continue fulfilling increasing orders while targeting continued improvement, the company has just been awarded a grant worth £50,000 from Leeds City



Robert Johnson, Managing Director of Craftsman Tools Ltd.

Council's Business Growth Programme. The grant will go towards the purchase of a new machine and taking on five new members of staff.

Speaking of the anniversary, Robert Johnson said: "For the past 65 years, Craftsman Tools has owed its success to the skills, dedication and loyalty of its workforce. With our continuing investment in technology and local people, the short and long-term future of the company looks very bright indeed."

Geo Kingsbury enters additive manufacturing sector

Turnkey metal cutting specialist Geo Kingsbury, has announced that it is also offering additive manufacturing solutions to its clients.

The move follows the company's appointment as exclusive distributor

within the same markets for AddUp Global Additive Solutions created in April 2016 by two giants of French industry, Michelin and the Fives industrial engineering group, which jointly own the company.

The venture was born out of Michelin's extensive use of powder-bed additive techniques for producing sipes for moulds, which give tyres their tread patterns, and the company's desire to commercialise its expertise. In September 2015 Michelin partnered with Fives, which brought advanced machine tool design and build experience to the business enterprise.

Richard Kingsbury, the managing director of Geo Kingsbury commented: "We have created a new additive manufacturing division at our offices in the Midlands, headed by Richard Hughes, to operate alongside our Large Prismatic Machines and Milling Turning Grinding technology divisions.

"We will be looking to include further additive manufacturing processes in our portfolio in the coming months, signalling our intention to move strongly into this expanding area of manufacturing."

The FormUp™ range of machines for direct metal multi-laser melting.



SUMITOMO develops a new solution for titanium alloy machining

A newly developed material with excellent wear resistance is achieving more than 40 times longer tool life than carbide for titanium alloy machining.

SUMITOMO has produced an ultra-hard Binder-Less Polycrystalline Cubic Boron Nitride (BL-PCBN) material named NCB100, synthesised under static ultra-high pressure and high temperature using a new method: direct conversion sintering. The new hard material consists of fine grains of several tens of nanometres, which are bonded to each other strongly and directly without containing any binder materials.

Thus, BL-PCBN has high hardness, high strength and high thermal conductivity that surpass conventional sintered PCBN compacts containing binder materials. Due to these excellent physical properties, BL-PCBN will be a solution for titanium alloy machining issues.

Titanium alloy is a hard-to-cut material because the temperature at the cutting edge rises significantly during machining which promotes adhesion on the cutting edge; resulting in heavy damage in a short cutting time. This is because titanium alloy parts are normally machined under low cutting speeds of less than 100m/min. The low productivity and short tool life are significant issues of titanium alloy machining.

BL-PCBN shows excellent wear resistance and achieves more than 40 times longer tool life than carbide under 200m/min cutting speed for - titanium alloy Ti-6Al4V finish turning application. BL-PCBN can be applied to near-titanium alloy Ti-5553 and also to Co-Cr alloy for medical implant parts such as hip and knee joints.

SUMITOMO is also promoting development of new tools for high-speed titanium alloy finish milling application near 700m/min cutting speed.



Castings Technology International grows to support expansion of titanium casting services

Castings Technology International Ltd (Cti) has increased staff numbers to cater for the uplift in demand for advanced titanium services that are now available to its members and end-users.

The company is now able to produce much larger and heavier near-net shape titanium components up to 2000mm in diameter by 2500mm in length, with a finished weight of approximately 500kg.

Cti General Manager, Richard Cook, said: "This is an exciting time for us as we are now able to offer manufacturing companies a wider range of titanium casting specifications than ever before, including increased envelope size and part weight.

"There is exceptionally high demand for cast titanium parts due to strong growth in the aerospace sector. So in order to offer existing and new clients additional capacity we have recently employed team members who are dedicated to

these processes."

The four new staff members will specialise in various aspects of the castings process from mould manufacture, melting, heat-treating and finishing; and will provide the impetus for both an increase in capacity and further reductions in lead-time.

"The titanium parts we manufacture are created utilising technology processes

unique to us. They are single-piece and potentially lighter than their forged or wrought counterparts, whilst offering equivalent or superior mechanical properties," said Richard.

Casting can be used to produce parts with incredibly complex geometries and features that would be almost impossible to create using more traditional machined and fabricated routes and can offer considerable buy-to-fly cost and resource savings.

Cti is one of a limited number of companies in Europe - and the only UK company - with the skills to cast complex structural parts from highly reactive metals like titanium. As such, Cti holds the aerospace quality management AS9100 accreditation and is fully UKAS compliant.

Cti also recently secured an accreditation from NADCAP to supply titanium castings to the civil and defence aerospace industries.



Divide and conquer with latest parting-off tools

Cutting tool and tooling system specialist Sandvik Coromant has unveiled a new blade for its CoroCut QD parting-off system, which substantially improves the tool's stability by realigning the resultant cutting force. Among numerous benefits available to the customer are improved productivity, enhanced surface quality and reduced noise levels.

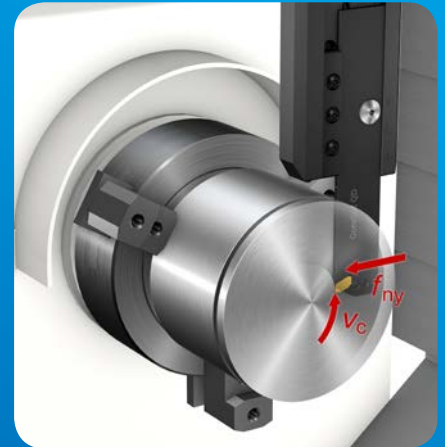
With conventional parting-off tool configurations on turning centres and multi-task machines, the capability of feed motion in the XZ plane is an inherent limitation. When performing parting operations the resultant vector of cutting forces is inevitably directed sharply across the tool's cross-section, leading to high loads and potential

deformation.

To remedy the situation, Sandvik Coromant engineers have developed a solution that takes advantage of capability in modern turning centres and multi-task machines to feed the tool in the Y direction.

In the new concept, the top face of the insert is placed parallel to the end of the blade, as if rotating the insert seat 90 degrees anti-clockwise. The new blade cuts its way into the workpiece with its front end, which roughly aligns the resultant vector of cutting forces with the longitudinal axis of the blade.

FEM analysis confirms that this eliminates the critical stresses typical to conventional blades and increases blade stiffness by six times compared



with standard designs. With enhanced stiffness, customers can increase feed rates or use a longer overhang without losing stability.

Prodtex Ltd develop a parallel kinematic robot for high-volume industry operations

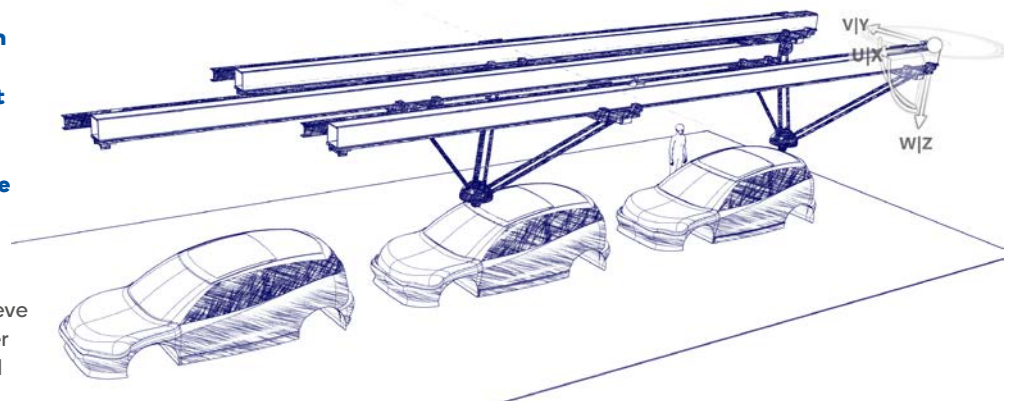
The manufacturing industry has seen a huge movement towards increased automation in production over recent years and a number of industries have tried to replicate the successful implementation of automation by the automotive industry.

As these robotic technologies and processes have been designed for the automotive industry they cannot achieve the tighter tolerance requirements over the larger working volumes demanded by other industries such as aerospace.

Many solutions have resolved this through the application of external factors such as metrology or external encoders to increase the accuracy of the robot arm. Automation technology development company Prodtex Ltd believes that, whilst this approach can be successful, it introduces unnecessary cost and complexity to the process.

A new type of robot which is designed from the ground up to meet the more demanding requirements of other industries is required.

Along with manufacturers of modular carbon fibre components Corebon and robotics solutions company Cognibotics, Prodtex is developing a



parallel kinematic manipulator based on ABB Tau architecture. The potential applications for this type of system include automated measurement, machining, automated fastening and automated sealing where the characteristic low inertia and high accuracy can be taken advantage of to perform high speed operations.

It has been designed as a low-cost stiff and accurate robot, whilst maintaining a large working volume. As opposed to traditional serial or articulated robots that come as an optimised unit from the robot manufacturer. A PKM Gantry-Tau can be assembled at the customer site

and reconfigured to meet various task requirements, without losing stiffness or speed if reconfigurations are within reasonable limits.

The robot is currently housed at the AMRC's Factory 2050 site and was recently demonstrated to a selection of delegates from the aerospace industry's leading manufacturers.

Prodtex Managing Director, Peter Helgesson, said: "The AMRC and Prodtex see a great opportunity for industry to take advantage of this technology and we are now looking for final applications with potential end customers."

Carpenter Technology continues to strengthen additive manufacturing leadership with cutting-edge expertise and industry-first innovation

Demand for additive manufacturing is growing – and so are the technologies and expertise from Carpenter Technology Corporation.

A leading provider of metal powders and wire for additive manufacturing, it recently announced two significant milestones – the strategic acquisition of MB CalRAM LLC (CalRAM), and the commercial production and availability of CarTech Puris® 5+ titanium powder – that expand and strengthen its capabilities and competitive edge.

Carpenter, a key player in the additive manufacturing space for decades, is now strongly positioned as a preferred provider and partner, particularly for mission-critical applications, such as aerospace engines and medical implants. The CalRAM acquisition

builds on the company’s industry-leading technologies, processes and expertise; providing Carpenter with direct entry into the rapidly expanding part production segment of the additive manufacturing value chain.

CalRAM was a Carpenter customer that turned to the company for help solving a complex challenge. That problem turned into a tremendous opportunity for both companies – and for additive manufacturing, resulting in the innovation of CarTech Puris 5+ titanium powder, the first high-strength, low-oxygen titanium powder solution.

Officially launched in 2017, the custom composition of Ti 6Al-4V signals a breakthrough in the ability to better control oxygen content inherent to additive manufacturing processes

without compromising powder strength. Preliminary testing on Electron Beam Melting machines is promising, with strength levels that exceed those of standard Grade 5 by almost 18 per cent.



Ricardo spins-out CryoPower

The Ricardo CryoPower concept is a potentially game-changing engine technology which aims to substantially increase fuel efficiency while reducing operating costs and CO² emissions for long haul trucks and other heavy-duty applications.

The technology has the potential to reduce operating fuel costs and fuel usage by, respectively, 20 and 30 per

cent in comparison with today’s heavy-duty engines (allowing for the financial and energy costs of the liquid nitrogen used by CryoPower in addition to its fuel).

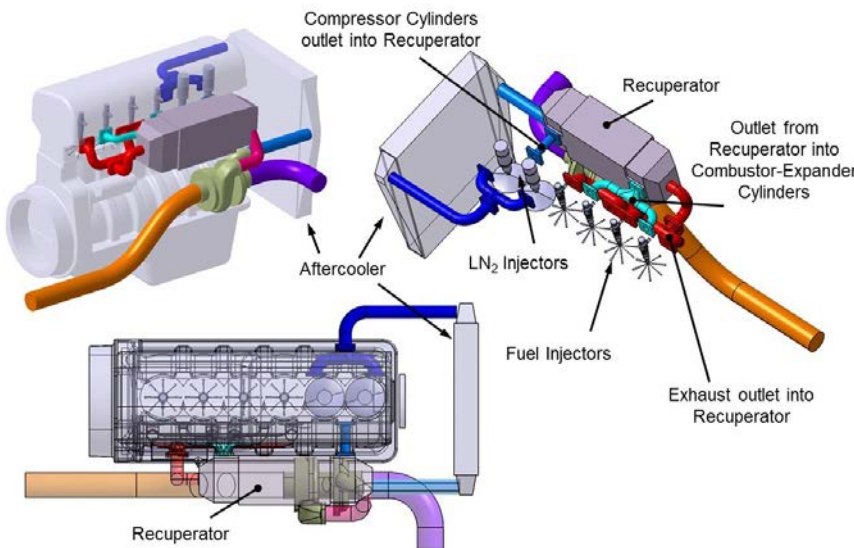
Spin-out company, Dolphin N2, has been formed to carry forward development of CryoPower technology towards market commercialisation. The company will be vested with all

CryoPower assets and IPR, and Ricardo will acquire a minority shareholding.

CryoPower uses separate induction and compression, and combustion and exhaust cylinders, enabling recovery of otherwise wasted exhaust heat to the working gas after the end of compression. The compression process is carried out isothermally, cooled via the injection of a small amount of liquid nitrogen which acts as both a coolant and an additional energy vector.

The combustion process utilises either renewable or traditional fuels, liquid or gaseous, and delivers heat energy back to the chilled and compressed intake air. CryoPower’s most important benefit, however, is to enable otherwise unachievable improvements in fuel economy, reduced CO² and other emissions through improved internal thermal efficiency.

Using liquid nitrogen generated in this way as an energy vector by CryoPower truck engines offers, Ricardo argues, one of the most effective pathways by which renewable energy can be deployed in long-haul, heavy freight road-based transportation.





AMRC signs MoU with GKN Aerospace to develop aircraft technologies of the future

The AMRC and global aviation supplier GKN Aerospace have entered into a long-term partnership to develop advanced technologies for the aerospace industry.

The AMRC works closely with global leaders in the aerospace industry to develop innovative technology, manufacturing methods and techniques.

It has signed a Memorandum of Understanding (MoU) with GKN Aerospace to progress a series of research themes they are developing together at the AMRC's state-of-the-art Factory 2050, the dedicated collaborative research factory home to the Integrated Manufacturing Group.

GKN Aerospace is a strategic supplier to Airbus, Boeing and other leading aircraft manufacturers, and plays a critical role in the UK aerospace industry.

It has been a member of the AMRC for a number of years and Chief Executive Officer at the AMRC, Colin Sirett, said the MoU not only reflects the strategic nature of the relationship between the two organisations but that it will bring significant benefits to both sides.

He said: "The purpose of signing the MoU is to recognise the strategic

role the AMRC is playing and to drive forward the significant amount of work and technological development we are embarking on with GKN Aerospace.

"What we will be looking at in a package of work with them is future manufacturing systems and digital linkage of those systems with the customer and the development of metallic machining technology.

"The AMRC will also have a core role in developing the Wing of Tomorrow technology with GKN Aerospace. This technology will be large scale assembly, metal materials machining and opportunities for castings.

"The plus point of the MoU for us is it enables us to operate very closely and effectively with companies that view the AMRC as one of their strategic partners."

As a global leader in manufacturing aerostructures, engine systems and specialist aerospace technologies, GKN works closely with universities, knowledge institutes, suppliers and customers to lead the industry in developing new technology to improve aircraft efficiency – lowering aircraft cost, weight and emissions.

It serves more than 90 per cent of the world's aircraft and engine

manufacturers and its technologies are used in aircraft ranging from single aisle aircraft and the largest passenger planes in the world to business jets and advanced fighter aircraft.

VP Global Technology at GKN Aerospace, Paul Perera, said the partnership will build on the collaborative research already underway between the two organisations. As part of the agreement, the Global Head of Additive Manufacturing at GKN Aerospace, Robert Sharman, will work with the AMRC's additive manufacturing research team as an associate professor.

Paul said: "The Memorandum of Understanding has been created between us to progress a number of joint themes which we have incubated here together.

"These are the application of digital manufacturing, the application of large scale additive manufacturing, and we have also been looking at large scale automation with the 'Wing of Tomorrow' project.

"It is a good partnership with true benefits on both sides. We really want to maintain the momentum on this agreement."

A call to focus: AMRC members have a new chairman to champion engagement



Rolls-Royce AMRC Partnership Manager, Dr Jamie McGourlay was voted in as the new Chairman of the AMRC Tech Board following the retirement of long-standing Chairman, Dr John Baumann of Boeing. Rebecca Ferguson speaks to him about his aspirations for the post.

The AMRC's Tech Board meets bi-annually for the industrial members of the AMRC to advise on topics of research and development, focusing on industry's commercial requirements and how funding for the AMRC's Board Generic Projects should be allocated.

Dr Jamie McGourlay is in a good position to lead the group, having been an official observer for many years. "It is a great honour to be appointed to be the new Chairman, as members and representatives look for someone who has an underlying understanding of how the Tech Board operates and understands its links into the wider governance, management and engagement of the partnership within the AMRC," he said.

"My time as Chairman comes after people like John Baumann, who it could be argued has most encompassed what the role is about. There's a lot of the work that John directed that I hope to continue."

Jamie has spent the last 14 years of his career based at the AMRC as Rolls-Royce Partnership Manager. As the company's principal representative on site, he oversees the joint research programmes that come to the AMRC on behalf of Rolls-Royce.

Jamie started at Rolls-Royce on a graduate training scheme in 1999. He spent 18 months working across the company before taking a job at the Turbine Blade Facility in Derby, eventually becoming a Process Improvement Leader there, where he specialised in directing and driving improvement within many of Rolls-Royce's manufacturing processes.

In 2004 Jamie joined the Central Manufacturing Technology team at Rolls-Royce to become their first Partnership Manager working directly with the AMRC as a newly joined Tier 1 partner.

He took up office at the AMRC's first building on the Advanced Manufacturing Park (AMP) in Rotherham, to find out what it was all about and what the AMRC model could offer. "We bought into it and were completely on board from the start," said Jamie.

From those humble beginnings, the AMRC site now has eight facilities spread over the AMP and Sheffield Business Park. Rolls-Royce's engagement has grown alongside the expansion of the AMRC; the global pioneer of aero-engine technologies now hosts three staff members - including

Jamie - at the AMRC.

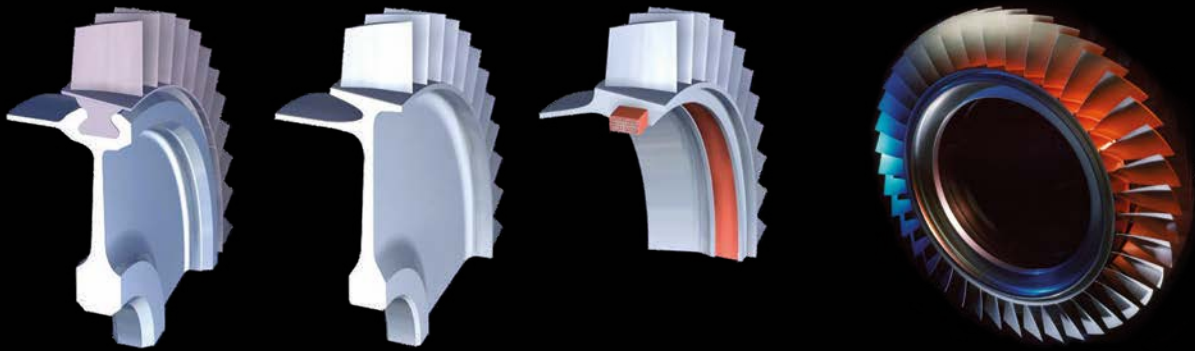
He said: "The relationship between Rolls-Royce and the AMRC is one that is still flourishing. As the AMRC has grown, so has our team here due to the support and subsequently benefit Rolls-Royce has drawn from as working as part of the membership."

Jamie's ambition is to ensure that all members acquire the maximum benefit from their AMRC partnership and to ensure the Tech Board is as effective as it can be for everyone from the global giants such as Rolls-Royce, to regional SME members.

"John occupied the board chair to represent broader engagement and as a call to focus as to whether we are operating the right processes and whether those processes are, in terms of managing the partners group and core underlying research activity, effective.

"That's as much as you can do as a chair, to try and get that input out of your fellow board members and to set strong and clear direction as a result."

Jamie will use his chairmanship to build on the engagement of the AMRC's partners through their network of members' activities; where progress and outcomes of research are discussed,



new projects and collaborations are formed and the development of future activities and capabilities which will provide most benefit to members is deliberated.

“It’s clear the AMRC groups take the subject of defining and delivering core research very seriously and I am looking forward to embedding that approach throughout the AMRC membership.

“I want to focus on getting the partners fully involved in driving the core research activity taking place, leveraging any further opportunities there are for research funding and championing any opportunities for collaboration with our university network.

“As the chair of the University of Sheffield Manufacturing Research Board, I am aware we have a fantastic base of wider resources out there we can draw on to drive our core research forward, such as our Industrial Doctorate Centre, which allows us to develop specific areas of technology over longer timeframes.

“Technology doesn’t go anywhere without the right people, drives and

capabilities to develop it. I do see the AMRC’s core research programme as a means of starting to develop leaders in particular technical fields.”

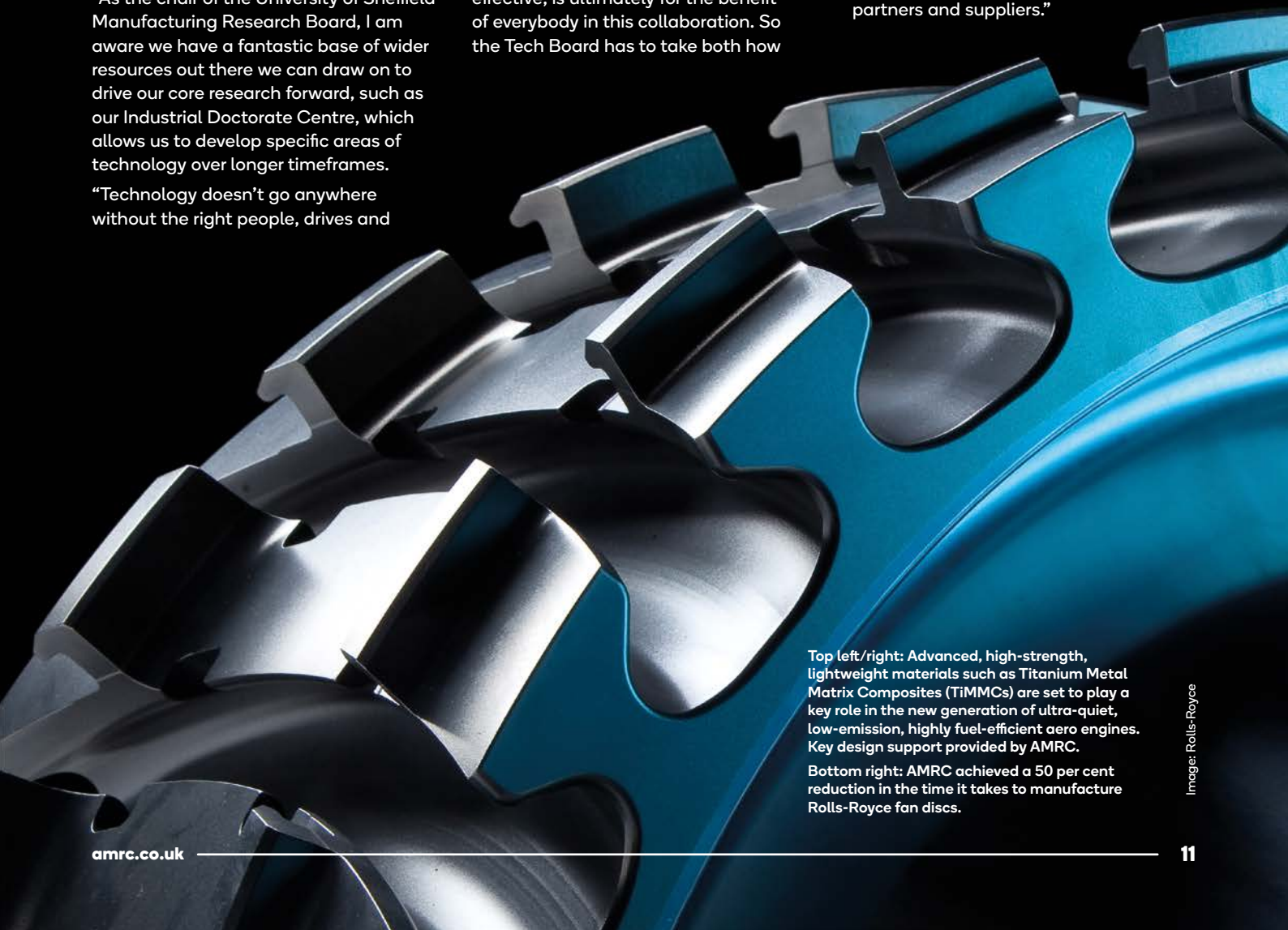
Jamie will also be championing more engagement from the AMRC members to support the AMRC’s strategic aims and influence them to ensure they are effective and for the benefit of everyone.

“For me, these processes keep the emphasis on new ideas and new innovation which when matured can be driven directly into partner led initiatives and opportunities, this is what keeps the AMRC fresh,” he said.

“We make sure the strategy that has been deployed is delivering and is effective, is ultimately for the benefit of everybody in this collaboration. So the Tech Board has to take both how

we define the work we do and how we deliver it very seriously because it’s the heart and soul of how the AMRC remains effective at what it does.

“Going forward I hope to continue to create a successful environment for the collaboration that happens within the Tech Board. It’s growing and diverse membership is a sign the AMRC is delivering on what it promises; it is a sign of wider industry and the supply chain realising that - as many of the original partners do - that here is a model that has something real and capable to offer and that is of advantage to their business to engage, whether to its drive its own internal capabilities or to simply get access and an understanding of its partners and suppliers.”



Top left/right: Advanced, high-strength, lightweight materials such as Titanium Metal Matrix Composites (TiMMCs) are set to play a key role in the new generation of ultra-quiet, low-emission, highly fuel-efficient aero engines. Key design support provided by AMRC.

Bottom right: AMRC achieved a 50 per cent reduction in the time it takes to manufacture Rolls-Royce fan discs.

Image: Rolls-Royce



Members of the AMRC Composite Centre and KraussMaffei in front of the bespoke RimStar Compact High-Pressure Resin Transfer Moulding System.

The AMRC announces its unique KraussMaffei high-pressure RTM system and composite press facility is ready for collaborative R&D projects

Rebecca Ferguson reports.

The bespoke KraussMaffei RimStar Compact is the most advanced High-Pressure Resin Transfer Moulding (HP-RTM) system operational within a UK research institution and is being used by the AMRC to support its research into developing novel composite technologies.

The facility is a world first in terms of its size, capabilities and the level of monitoring and control it can provide the AMRC Composite Centre.

The system comes complete with unique dual resin feeds and mixing heads; where the resin and hardeners are mixed at the impingement head located in a closed, matched mould under a high-pressure colliding process to be instantaneously injected into the preform.

The multiple heads mean resin flow rate is higher and large, but lightweight net-

shape parts can be achieved with the maximum amount of resin input. AMRC Composite Centre Research Engineer, Darren Wells, said: "This unique feature of the system allows us to extend the range of highly reactive, but fast-acting resins and hardeners we work with, giving us greater flexibility to conduct research with novel or unusual composite materials and produce more complex geometric component structures.

"These highly reactive resins are being used more frequently within HP-RTM techniques and have made it possible for us to bring cure times down to within three minutes. This dramatic reduction opens up the potential for manufacturers to take advantage of huge savings in turnaround times."

A UK manufactured press with two separate lower platens that allow for

both heated and cooled processes complete the system. Their large working envelopes can be adapted for more complex tooling geometries and will open up opportunities for manufacturers where high customisation, but high-volume production is required.

"There are wide-ranging benefits of using this new system in our research, which include improved processing times and cost, but also improved use of raw materials as no pre-preg, or 'pre-impregnated' composite material is required," said Darren.

Today, industry uses simple 'preforms' of composite material which are impregnated with polymer resin and cured to create composite material. "On our bespoke KraussMaffei high-pressure RTM system, the injecting and curing of composites all happens in the same mould, which means parts are

structurally sound and consistent in quality and material characteristics,” he added.

“This means there is a higher repeatability of the process, as it removes the variability of quality within pre-preg materials that stems from the laying and curing processes.

“Often pre-preg additives are used to improve toughness during composite curing processes, especially for safety critical or structural composite components, but the viscosity is too high to inject under HP-RTM processes, so we are looking at lower viscosity additives and how they are mixed into the resin or preform so they don’t disrupt fibre layout.”

The AMRC Composites Centre now has the capacity for a variety of research collaborations to utilise this cutting edge high-pressure composite facility.

“There are huge areas for potential growth in using composite technologies for many sectors as HP-RTM is ideal for manufacturing integrated, lightweight structures with extremely fast cycle times,” said Darren.

“The KraussMaffei system provides us with immense machine flexibility thanks to its modular design, allowing us to tailor its configuration to specific customer requirements. This enables a wide range of UK manufacturers the opportunity to exploit the advantages HP-RTM processes have to offer such as improved through-put and cost savings,” he added.

“We are looking forward to our future relationship and development programme with the AMRC, particularly in the area of aviation, where we see great potential for HP-RTM composite components. As a result of a recent AMRC automotive development programme using the KraussMaffei supplied HP-RTM equipment, KraussMaffei has received a serial volume production order for a HP-RTM metering from a UK based performance vehicle manufacturer”, added Stephen Lambert, RPM Business Manager KraussMaffei Group UK.

The AMRC Composite Centre can be reached at:

**compositecentre@amrc.co.uk
or +44 (0)114 222 1747**



The HP-RTM system is a world-first in terms of size, capability and monitoring and control.

“These highly reactive resins are being used more frequently within HP-RTM techniques and have made it possible for us to bring cure times down to within three minutes. This dramatic reduction opens up the potential for manufacturers to take advantage of huge savings in turnaround times.”

Darren Wells, AMRC Composite Centre research engineer.



The UK manufactured press allows high-customisation with high-value production.

MACH 2018

AMRC brings the Fourth Industrial Revolution to the small businesses of the UK at MACH 2018

The AMRC has been on a mission to show how digital technologies can unlock game-changing value streams, by breaking down the barriers to adoption and demonstrating low-cost and low-risk solutions for even the smallest of businesses.

Rebecca Ferguson reports.

This year at MACH 2018 the AMRC partnered with the Manufacturing Technologies Association (MTA) to provide a unique showcase, replicating familiar manufacturing environments integrated with Industry 4.0 technologies.

The exhibition was an ideal venue for the AMRC to dispel misperceptions of the cost and complexity faced by SMEs when wanting to adopt these technologies.

AMRC Software Engineer Matei Moldoveanu, hosted one of IMG's star attractions, a project to retrofit a legacy milling machine and lathe with a number of low-cost, digital technologies.

This Industry 4.0 technology allows data acquisition to enable accurate monitoring of the condition of the machine and give production managers valuable information about energy consumption and performance.

"The diversity of companies interested in our legacy project was incredible, from the smallest of SMEs interested in how we could help implement similar systems to improve their operations, to major global companies wanting to achieve the same outcomes by upgrading still valuable legacy manufacturing processes," he said.

"The interest in the demonstrator shows what determination companies have to preserve and upgrade legacy manufacturing processes that still provide value, by taking advantage of the potential benefits of Industry 4.0 technologies through low-cost investments."

Head of Digital at the AMRC, Professor Rab Scott, said: "The reaction to the stand surpassed our expectations. We expected a great response to the demonstrations of the latest technologies like VR and AR – areas

in which we are arguably amongst the leading integrators, but what has really cheered us up is the way in which attendees have reacted to our legacy equipment demonstrations.

"People were excited to see the 1956 Colchester Bantam lathe, some saying they trained on one of these, or they have one in their company and didn't realise how easily and cheaply they could digitally enable these workhorses of the installed SME base."

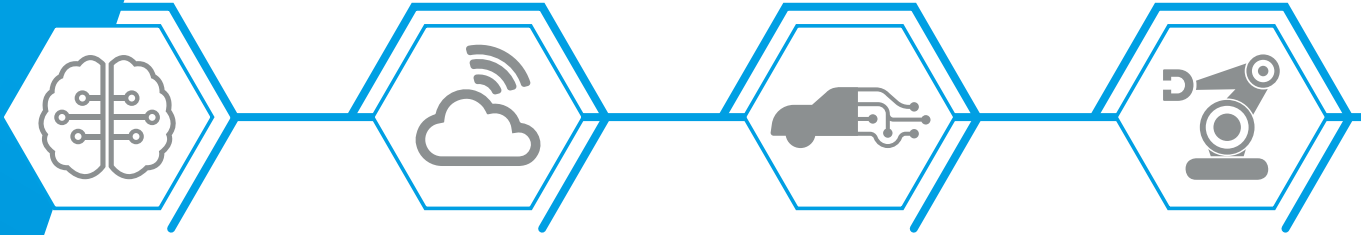
Professor Scott also said that this reaction validates the decision of the AMRC and MTA to put together this showcase: "UK manufacturers want to adopt Fourth Industrial Revolution technologies and have been looking for exemplars of how to do it in ways which don't cost the earth and which minimise disruption business as usual.



A team from our Integrated Manufacturing and Machining Groups was put together to host the AMRC stands.



Demonstrating the legacy milling machine retrofitted with low cost sensors.



Project RAID at MACH 2018.



Olympic champion Ben Ainslie visited the AMRC stand after officially opening MACH 2018.

By attending MACH they have seen that the start to their digitalisation journey is within reach.”

MTA CEO James Selka said: “It is vital that we help SMEs to find cost effective ways to get their businesses digitally enabled if UK manufacturing is to fully embrace the Fourth Industrial Revolution. That’s why we’re delighted to have been able to partner with the AMRC on this project. With the technology that is available and affordable every business should be thinking about getting digital.”

Another attraction that gained a lot of attention from visitors was IMG’s Reconfigurable Assembly Integrated Demonstrator, or Project RAID. This project shows how advanced technologies can be tailored to any complex full assembly process and used to fuel improvements in manufacturing productivity.

The team assembled half of a Caterham sports car by hand as per the written

instructions. Then built the other half using a variety of technologies covering all the themes of research currently underway in Factory 2050; including robotics, automation and control, integrated metrology, digitally assisted assembly, manufacturing informatics and visualisation of data to collect information about the various construction processes along the way.

The technologies being implemented are designed to be easy to integrate and demonstrate their ability to drive even the most advanced of Industry 4.0 manufacturing techniques and processes.

The whole project is being powered by a manufacturing operations system called DELMIA Apriso, from Dassault Systemes.

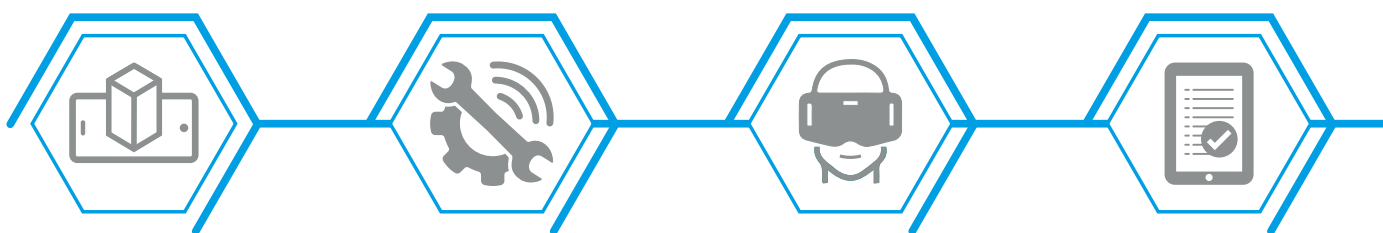
AMRC Project Manager, Alex Godbehere said: “DELMIA Apriso is the system we have used to develop our Manufacturing Execution System (MES) for Project RAID; this is the system that controls all

of the manufacturing processes for the assembly of the Caterham.

“The MES is an intelligent system that shares information, so if the specification for a component or work instruction changes, the system is able to intuitively update and keep the assembly process running effectively.

“We have used the system with Project RAID specifically to show how we can develop a system that can create complex work instructions from CAD information and be intuitive enough to validate a system that can be adapted for a variety of industrial requirements.”

Sinan Ozbek, from Dassault, dropped by the stand to see the system in action. He said: “The work the team has done on Project RAID is really impressive. I’ve visited DELMIA Apriso users across industry and countries and the AMRC technology demonstrator is one of the best I’ve seen, a great achievement. It was great to see it in action and generating so much attention.”





AMRC Training Centre apprentice Ben Siddall latest rising star to win ‘Apprentice of the Year’

Twenty-one-year-old, Ben Siddall from Barnsley became the fourth apprentice to win the honour of being named ‘Apprentice of the Year’ at the AMRC Training Centre’s annual award ceremony at the University of Sheffield’s impressive Firth Court Hall.

The awards were generously supported by Boeing, and Ben - who works as a Production and Perforation Department Manager for C&S Fabrications in Sheffield - will now get to tour Boeing’s commercial aircraft factory facilities in Washington State, outside Seattle in the United States, to see first-hand how the world’s largest aerospace company designs, tests and builds its 737, 777, 747 and 787 aeroplanes.

The Apprentice of the Year Awards uses nominations from employers and trainers who want to recognise the achievement, innovation, fresh thinking or contribution to industry exhibited by

our apprentices, and are judged by a panel of AMRC Training Centre staff and award sponsors.

This year the judges were struck by what a positive effect Ben has made within his workplace. His strong work ethic and determination to succeed has already resulted in a promotion. The judges were impressed by Ben’s passion and his infectious enthusiasm for engineering; making him a great ambassador for manufacturing.

Speaking at the awards, Ben, said: “I am totally shocked and surprised to have won Apprentice of the Year! I was grateful just to be nominated and have

people put me forward for the award who thought I was deserving of the honour!”

Ben said one of the main highlights of his year was utilising the skills he has learnt at the AMRC Training Centre to support improvements in-house at C&S Fabrications, such as applying the use of 3D CAD learnt as part of his technical support course.

Managing Director of C&S Fabrications, Shaun Siddall, was at the event. He said: “We are so proud that Ben has won Apprentice of the Year, he is such a fantastic representative for our company.

Other winners at the AMRC Training Centre Apprentice of the Year Awards were:

Machining Apprentice of the Year – David Carroll of Doncasters Bramah. Sponsored by Sandvik Coromant.

Technical Support Apprentice of the Year – Ben Siddall of C&S Fabrications. Sponsored by The Source Academy.

Fabrication and Welding Apprentice of the Year – Kyle Heighington of Wilson Brothers Ltd. Sponsored by Sheffield International Venues.

Maintenance Apprentice of the Year – Joshua Brookes of Thos C Wild Ltd. Sponsored by Hexagon Manufacturing Intelligence.

Academic Achiever of the Year – Benedict Bloomer of Arconic Forgings and Extrusions. Sponsored by Barnsley College.

Higher Achiever of the Year – Oliver Heafield of Rolls-Royce. Sponsored by The University of Sheffield.

First Year Apprentice of the Year – Will Morton of Tribsonics Ltd. Sponsored by the AMRC.

AMRC Training Centre Mentor of the Year – Chloé Fairman. Sponsored by Apprentice Employment Agency.

Special recognition awards (sponsored by the Manufacturing Technologies Association, Cutwel, Stanley Black & Decker and Close Brothers Group plc) were also given to Abbie Plummer of Symphony Group, Andrei Popa of CAM Hydraulics Ltd, Sam Cowley of the AMRC and Jacob Martin of Chesterfield Special Cylinders for their exemplary achievements, attitude and contributions to the Training Centre throughout the year.



“Ben has brought a new and different approach to the company and as a result has implemented process improvements that have brought great benefits to our workplace, all completely under his own initiative. Bringing in younger talent definitely brings in fresh new ideas and attitudes and having an apprentice join us from the AMRC has been such a worthwhile experience.”

Director of the AMRC Training Centre, Nikki Jones, said: “The Apprentice of the Year Awards is the highlight of the Training Centre’s calendar; it is a fantastic opportunity for us to celebrate the achievements of our apprentices and shows, with the right attitude, commitment and support, just what anyone can achieve.”

“All of our apprentices work hard to achieve the best results, and it is an honour to see some shining examples of success here tonight, our apprentices really are a credit to themselves and their companies.”

Professor Sir Keith Burnett, President and Vice-Chancellor of the University of Sheffield, said: “I would like to extend my warmest congratulations to tonight’s winner Ben on his success.”

“Our apprentices are an important part of our University and prized to the companies who sponsor and employ them. The AMRC Training Centre gives people a crucial alternative route into higher education so here at the University and the AMRC, we are further able to attract the clever and talented

individuals that are such a magnet to inward investors seeking skills and a crucial part of the U.K’s future economy.”

Ben said: “I always knew I was interested in engineering and would join that profession. My apprenticeship with the AMRC has been the stepping stone that set me off in the right direction in my career and given me the practical skills that I needed to progress in my workplace.”

“In the future I look forward to working my way up within my company and working hard to keep making improvements. I am excited to see what the future holds from here!”



Leigh Worsdale, AMRC 'Apprentice of the Year' 2017 on her trip to Boeing in the USA.



Success is all about the right attitude for award-winning apprentice Leigh Worsdale

As the latest winner of the AMRC Training Centre's Apprentice of the Year Awards has been announced, we took a look back over the last year with the 2017 winner of the title, Leigh Worsdale.

From media appearances, to job offers from around the world and starting the journey to becoming a young apprentice ambassador, the last 12 months have been a whirlwind for the AMRC's first female Apprentice of the Year and heavy duty diesel engine builder, Leigh Worsdale.

When asked what the highlight of her year is however, she will tell you that what gives her the most satisfaction is knowing she is contributing to the

success of her employers, Chesterfield company Foxwood Diesel:

"Seeing my company grow and the changes I've been able to make to a small developing business has been my highlight, I feel like I've played a big part in building the business up.

"I started off improving health and safety standards, ensuring the working environment was clean and went onto change manufacturing systems to make them more efficient and effective; cutting cost, reducing waste, improving stock control and time management. Employing these kinds of process improvements really affects not just the working life of the staff, but productivity as well."

It is this kind of forward-thinking and dedication to her workplace that landed Leigh the coveted title of 'Apprentice of the Year' in 2017.

The judges were 'overwhelmingly' impressed by Leigh's confidence and spoke about how she continuously seeks ways to improve her workplace and its processes.

Leigh's achievements also led to her being awarded 'Chesterfield's Apprentice of the Year' in the North Midlands and South Yorkshire Apprentice Awards

“Apprenticeships really do make a difference to the lives of young people, I am evidence of that!”

and ‘Highly Commended Advanced Apprentice of the Year for the East Midlands’ in the National Apprenticeship Awards.

The jewel in the crown of her award-winning year was her trip to the USA hosted by Boeing, where Leigh enjoyed a tour of the aerospace giant’s sites in Los Angeles, Portland and Seattle – learning more about the world-renowned manufacturer as her prize for winning Apprentice of the Year.

Leigh never expected her award to bring her so much attention: “The awards just kept on coming this year, it’s been an amazing experience! It’s great to have your achievements recognised in that way, especially by Boeing.

“I was also invited to demonstrate Industry 4.0 technologies to Members of Parliament at a High Value Manufacturing Catapult event at the House of Commons. It’s a big honour to be seen as a representative for the AMRC Training Centre.”

These events sparked a unique opportunity to work with the Young Apprentice Ambassadors Network. Leigh will now be a figurehead for engineering apprenticeships in Yorkshire and share her passion for engineering with young students.

Ellen Messias, Project Director for the Young Apprentice Ambassador Network, said: “We will be supporting Leigh to engage with students, parents and teachers to inform them about the higher educational options available within apprenticeship training.

“Leigh is perfect for this role as she speaks so passionately about her work and is so committed to her apprenticeship. She is well placed to help support young people to make informed decisions about their future.”

Leigh is now an experienced ambassador; she has appeared throughout print and broadcast media, becoming the face of successful

apprenticeship training in the Sheffield City Region.

In January 2018 she was interviewed on BBC Radio 4’s flagship Today programme which was broadcast across the nation from the AMRC Training Centre and she will soon be represented in a series of short films highlighting outstanding early career professionals for the Great Exhibition of the North.

Looking back on her year, the evidence is clear to Leigh that all her hard work is paying off: “I’ve had so many opportunities come my way and received job offers from all around the world, which shows just how much opportunity there is out there for young people doing apprenticeships.”

Leigh’s apprenticeship has given her grand plans for the future and she is now furthering her higher education by completing her Level 4 HNC studies. She is also pursuing training opportunities to diversify her skills and knowledge of modern engine technologies:

“I would like to travel, so gaining more qualifications will be imperative to allow me to take advantage of opportunities abroad, having all those contacts from job offers will come in useful!

“A successful apprenticeship is about having the right attitude; I always take any opportunity the AMRC Training Centre gives me, any extra training I sign up for. I tell people that the AMRC will give you the skills to go as far as you want to go in life. I wouldn’t be the person I am today without my apprenticeship.”

For the time being however, she is invested in company life at Foxwood Diesel, using her knowledge to focus on improving manufacturing systems and costs: “I feel my apprenticeship has been so successful. I want to spend time seeing what other improvements I can make. Seeing a small 10-person business grow due to the effect of the new ideas you can bring in is immensely rewarding.”

Ken Worsdale, Director of Foxwood Diesel knows

the value of apprenticeship training: “Foxwood Diesel has a long history of employing apprentices over the years and in fact, everyone currently working at the company started their career as an apprentice.

“Working with the AMRC Training Centre has improved our standards not only as a business, but as a team as well and Leigh has been the connection by adding new and improved systems and procedures.

“Leigh is not only a skilled engine builder but her business knowledge has improved dramatically since starting with us as an apprentice and her next step at Foxwood Diesel is to become a mentor by showing other staff how to work with the systems she has developed and installed.”

For Leigh, an apprenticeship was all about getting the experience and the opportunities for career development she needed, whilst being able to earn a wage. She encourages anyone considering an apprenticeship to go for it: “Do it! Anyone can be successful, my story isn’t unusual, I just work hard and I am given the right focus. I still feel like there is still a stigma to undertaking an apprenticeship, but now things are changing and the benefits, not just for the young people but for their companies and UK industry, are finally being seen.

“Apprenticeships really do make a difference to the lives of young people, I am evidence of that!”



Leigh Worsdale
Mechanical Manufacture Apprentice, Foxwood Diesel

SHAPING THE FUTURE

Leigh being interviewed by ITN.

Oliver makes his mark

AMRC Training Centre apprentice, Oliver Marsh, scooped a major industry apprenticeship award for his role in helping the UK's largest manufacturer of wheelie bins reduce the cost of its production processes by more than £135,000 a year.

John Yates reports.

The 21-year-old aspiring rock musician, an apprentice with the OnePlastics Group, was the clear winner in the plastic industry's equivalent of the Oscars – Polymer Apprentice of the Year Award – the official ceremony for which was held in London.

A few weeks later he was making national news with being interviewed by Justin Webb on the BBC's agenda-setting Today programme during a three-hour outside broadcast on the shop floor at the AMRC Training Centre along with some of his former colleagues.

Barnsley-born Oliver, who works in the Group's state-of-the-art, highly automated MGB Plastics factory in Rotherham, said he was delighted to win the award: "It's a privilege and an honour to get this award. Working at MGB has been brilliant; the company has given me so much support and encouragement. My mentors at work have taught me how to use lean techniques and processes to drive improvements in productivity and performance. But the start of my journey began with the AMRC."

In her response to the news that Oliver had won the award, AMRC Training Centre Director, Nikki Jones, said she was delighted that his talent had been recognised: "Oliver was a very dedicated and hard-working apprentice, quick to develop new skills and eager to learn more. His achievement is proof that investing in good apprentices pays real dividends."

MGB agrees. Having spent more than £25 million in advanced technology, including large presses, the company was equally keen to invest in its human capital: training the next generation of polymer engineers in its three plants at Rotherham, Tamworth and Hull.

Gary Blanshard, MGB Plastics Technical Manager, said the firm wanted to bring bright young engineers into the business to maintain its position as market leader in the supply of wheeled bins. "We decided that the best way forward was to get someone on board who had no pre-conceived ideas of how things should be done. The way to do this was to train them from scratch," Gary said. "We invited the AMRC Training Centre to

visit us and discuss what they could offer in the way of apprenticeships. They then advertised for a Technical Apprentice and created a short list of candidates. After an extensive interviewing, Oliver was offered the position and began his apprenticeship with us.

"Having gained knowledge of CAD at the AMRC Training Centre, he has used this to great effect with us. He used CAD to model the fit of our lids, which some customers had identified as an issue, and found a mismatch between the hinge fixing pin and the bin mating hole. He redesigned the pin and improved the tolerances using CAD. Having tested a prototype and run moulding trials on the new hinge pin, he proved out the fit and function through assembly trials."

But it is Oliver's use of lean principles, taught by his close mentors, that has most impressed his colleagues. "He has transformed what was already a market leading printing technology used to emboss the more than 1.5 million bins we produce each year," said Gary. "Oliver's forensic examination of the change-over process from one council crest to another has turned the operation into the polymer equivalent of a Formula One pit stop – fast, efficient and very slick.

"We estimate that this improvement alone is saving the business in excess of £137,000 a year by getting the plate changes down to just 34 seconds from 10 minutes. It is a brilliant example of a single-minute exchange of die (SMED) approach, which Oliver has picked up very quickly and developed with us. He is now a key member of our plant automation team tasked with taking significant costs out of the business, and is looking at how the firm's equipment might need to be uplifted to meet new industry standards. If there is a productivity-critical issue, Oliver is in the mix."



AMRC Apprentices Sam Cowley, Leigh Worsdale and Oliver Marsh with AMRC Training Centre Director Nikki Jones (centre) and the BBC's Justin Webb (centre right) during Radio 4's Today Programme broadcast.



Oliver has come a long way fast. He is a vital member of the MGB team with responsibility for:

- *Measuring chilled water flow and temperature data and to highlight any trend changes before they cause production issues.*
- *Monitoring and maintaining each machine cycle time.*
- *Challenge the shift production team to give valid reasons for any that are running out of standard – rectify any problems.*
- *Technical support to Quality Engineers.*
- *Providing accurate process setting data to reduce start-up rejection.*
- *Carrying out new product and material trials.*
- *Processing support and training to the shift Production Technicians.*
- *Providing operating performance data for the Senior Management Team.*

He is also a key member of the firm's plant automation team tasked with taking £117,000 of costs out of the business. His work has now gone to the Managing Director for consideration and approval. The company has also tasked him

with looking at how their existing equipment might need to be uplifted to meet new standards for the industry.

When not saving his company six figure sums with his ingenuity, Oliver is bass player in the band Alba Rosa – White Rose – who were recently centre stage at the O2 Academy in Sheffield as support to The Lost Days. He now has to decide whether his future lies in driving bass lines for the band, or production lines for OnePlastics.

Whatever he chooses, his fan base is growing in both places.

A spur to innovation

Three recent Innovate UK funded projects have just been completed by engineers at Factory 2050. John Yates talked to the teams involved to see how Innovate UK funding is helping drive the adoption of digital technologies in construction and among small and medium sized manufacturers using legacy equipment.

Augmenting productivity and collaboration

When Mark Farmer's report landed on the Construction Industry Leadership Council's desk two years ago the message was clear: Modernise or Die. And that meant adopting digital and advanced manufacturing technologies to improve productivity and enhance the skills and training of a much more agile and collaborative workforce. But which digital technologies?

For many in the industry, the choice of technologies is both vast and confusing. Now, a new report by the AMRC's engineers in Factory 2050, *Augmented Worker: Capture*, guides would-be adopters of smart digital visualisation technologies through the seemingly impenetrable maze of options.

Authors of the Innovate-funded research, Chris Freeman, Sean Wilson, Jonathan Gray, Audrey Chivaura, and Carlos Frias, take the reader on an eye-opening journey through the different augmented reality (AR) delivery methods – including projection, tablet, monocular and binocular displays – and the diverse mobile capture devices on the market including 3D scanning, thermal capture and hidden asset capture.

“Our report is centred around the creation of an asset management application using AR to supplement an operative's vision with objects or assets that are currently hidden or obscured from view. Using the thermal and hidden asset capture technology, multiple live data feeds can be taken from these third party devices and plotted in the technician's field of view within the augmented environmental,” says the AMRC's Augmented Reality Technical Lead, Sean Wilson. “The delivery platform enables captured data to be



Augmented reality used to create building information model (BIM) data on-site.

overlaid onto the real-world assets, contextualising the data in real-time and drastically reducing the delay between data capture and data interpretation. The report also looks at how the data captured can be stored and exported in a BIM level 3 compliant method.”

The authors build on the AMRC's industry-backed Augmented Worker (AWE) project to provide a visually driven interactive platform for the construction industry that will enable intelligent design, monitoring and maintenance of construction projects by providing a greater level of collaboration and communication between teams and partners on projects. “Reducing the need for paper or mobile based handheld devices, also gives workers a hands free, heads-up solution for a greater level of safety whilst providing real-time visualisation on-site,” says Wilson.

The economic benefits will ensure efficient and successful construction projects with significant return on investment being realised relatively fast. Industry-wide adoption of digitisation through BIM and smart systems, such as the AWE capture asset management

system, will also drive a change in culture within the construction sector to one that is much more collaborative.

Projecting the right image

The tallest luxury residential tower in London was the test-bed for a novel projection demonstrator developed by the AMRC which looks set to yield more than 50 per cent productivity improvements for skilled construction tradesmen, along with big gains in the quality of final fit-outs.

Two-Fifty-One in Southwark, which topped out last month at a height of 131 metres, was provided by Laing O'Rourke as a use-case for an Innovate UK funded project that explored how digital projection technologies could be deployed in marking-up component positions such as power sockets, lights and sprinklers.

“The construction industry has changed very little over recent decades, but, as the Farmer Report demonstrates, it needs to embrace digital technologies if it is to remain competitive and improve



The projection system on-site.

argins,” says Chris Freeman, the AMRC’s Factory 2050 digital theme lead.

“The industry may use Building Information Modelling (BIM) to design a building, but the digital journey seems to end at the building site where trades use drawings to complete the construction. Our demonstrator is a simple, smart and effective way of bridging the gap between digital design and paper-based construction processes,” says Diego Aranda, AMRC systems technical lead who managed the project.

The results are staggering. Operators who tested the bespoke projection mapping system on a number of prestige buildings in the capital were able to complete the mark-up process of an entire floor in 34.5 hours: a time saving of 45.5 hours. This is chiefly due to the way the software has been adapted to allow operators to map and project a PDF drawing onto a wall, floor or ceiling within an apartment.

The solution the team came up with interfaces with other data and documents; knows what to project and where; is easily moved; requires minimal user training; minimises potential tripping hazards; and has the robustness for construction.

“Our design is both simple and robust and the operators really like its ease of use,” says AMRC Senior Project Engineer, Arthur Kershaw, who designed and built the dolly-based projector system. “It might not look hi-tech, but that is part of its attraction to the trades

people. One of the challenges of digital technology is that it can frighten people off: this is instantly recognisable and accessible.”

A 3D model of an apartment building was used to understand how the spatial limitations of the site would dictate the required throw distance of the projector. The size and shape of the projection unit was such that a sack truck was an ideal transport medium for the entire system. Prototype designs were made which would allow mounting the projection unit onto a sack truck. This would allow for the system to be easily moved around the site and provide a stable platform to project from.

Making sense of sensors

Low-cost sensor technologies being developed at the AMRC could significantly reduce the barriers to adopting digitalised manufacturing processes, from asset tracking systems in the construction industry through to retrofitting smart devices to older, legacy machine tools to increase machine tool uptime and the shift to more predictive maintenance.

The work, captured in the Innovate UK funded SenSmart project report, explores all the technologies currently available and then drills down into at Radio Frequency Identification (RFID), WiFi, Ultra-Wideband, and other technologies, which includes Bluetooth Low Energy (BLE) a current industry standard, as these offer the best balance between coverage, accuracy and cost for indoor applications, especially in factories.

For those who are unsure which would be the most appropriate technology to

adopt, the authors of the new report, Aiden Lockwood, Rikki Coles and Matei Moldoveanu, provide a comprehensive survey of what is available, from the various cloud platforms – IBM Cloud, Amazon, Google and the Siemens Mindsphere – through to the technology, application and data architectures.

The team looked at location tracking in a manufacturing environment using a variety of methods, including BLE. The research showed that whilst this a good technology its performance is greatly affected by interference from other devices; attenuation from concrete, water, and in particular the personal devices most people now carry, which all absorb RF energy around 2.4GHz; multipath effects caused by indoor spaces with metal surfaces which may lead to self-interference of the signal; and polarisation - if the tag and receiver are not co-polarised, which is often the case in standard setups, this reduces signal intensity.

In addition, the report also discusses the technologies utilised as part of the two legacy machine tool demonstrators – a 1956 Colchester Bantam Lathe and a 1972 Bridgport milling machine – which proved to be a sensation at the recent MACH 2018 exhibition (see report on page 14) and showed just how easy it is to fit either ultra-low cost hobbyist sensors or still relatively inexpensive, robust industry-ready technologies.

“One of the main drivers behind digitalising legacy equipment is to enable smarter monitoring and to provide machine owners better insights to make more informed decisions around maintenance and machine health,” says the AMRC’s Aiden Lockwood, Technical Fellow for Manufacturing Informatics and Industry 4.0.



Sensors turn legacy lathes into smart machine tools.

The reality behind virtual machining

AMRC engineers are part of a five-nation research project helping Europe's €23 billion machine tool industry stave off competition from the Far East, and drive productivity improvements in high-value manufacturing in the automotive and aerospace sectors.

John Yates reports.

Erdem Ozturk has an eye to the future and an ear for the past. His work on virtual machining for Horizon 2020's multi-million-pound Twin Control project may be at the cutting edge of digital technology, but he knows it is dealing with problems identified more than a century earlier by the American pioneer of scientific management, Frederick Taylor.

"I first heard of Taylor and the problem of chatter when I was asked to write a short essay on him during my second year at Middle East Technical University," says Erdem, who leads the virtual machining work package of a project whose partners include French car maker, Renault and Spain's MASA Aerospace.

"Taylor was the productivity guru of his time. His equation identifying the relation between cutting speed and tool life was invaluable for machining process planners. It helped them understand how much tool life would decrease with increased cutting speed," he added.

Erdem's fascination with dynamic machining led to a Masters, under the watchful eye of Professor Erhan Budak, and another connection with Taylor.

Budak had developed a method for the design of variable pitch milling tools that increased material removal rates by optimising stability of the process. His achievement led to the award of the coveted Taylor medal by the International Academy for Production Engineering (CIRP).

But it is Taylor's 1907 book 'On the Art of Cutting Metals' that still fascinates the man leading the AMRC effort to help improve machine tool productivity using virtual machining and process monitoring techniques undreamt of in the early 20th century.

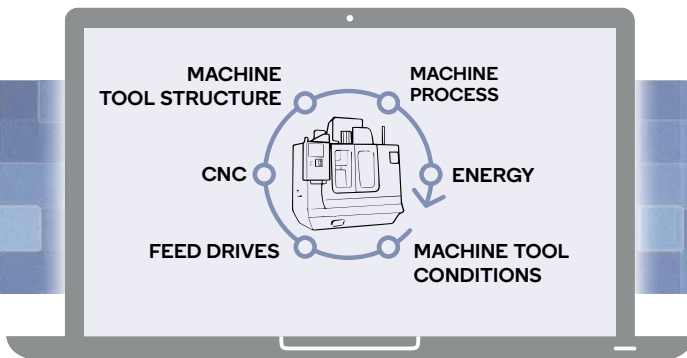
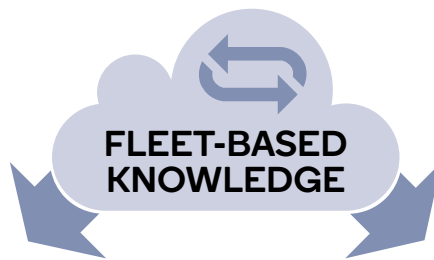
In his book Taylor notes that "chatter is the most obscure and delicate of all problems facing the machinist – probably no rules or formulae can be devised which will accurately guide the machinist in taking maximum cuts and speeds possible without producing chatter."



"He was absolutely right," says Erdem. "There was no formula available to predict chatter vibrations until 1954, and even now the fight against chatter is continuing as innovators develop new processes, tools and materials for the manufacture of high-value components. As researchers, we are working hard on developing and improving predictive models to catch up with these developments to serve the needs of machining industry. We have a fast growing knowledge of virtual machining and optimisation at the AMRC.

"Knowledge that could save the machine tool makers and end-users, tens of millions of pounds. We know, for instance, that as much as 53 per cent of the total life cycle costs of a machine tool is related to maintenance and electricity consumption. By developing accurate predictive tools, we could significantly reduce the cost of maintenance and drive big improvements in productivity. And that is the goal of Twin Control."

The project brings together private and public sector partners in Germany,





Images from the AMRC and Twin-Control Virtual Machining Conference video, presented by Dr Erdem Ozturk. Search YouTube: 'AMRC Twin Control'.

Belgium, France and Spain in a concerted effort to develop a new breed of integrated 'simulation models' based on sophisticated sensors embedded in machine tools and cloud-based data analytics. The AMRC Machining Dynamics team, led by Erdem Ozturk, is delivering the virtual machining solutions in the project along with Luke Berglind.

With just six months remaining on a three-year project, Erdem is confident that the solutions being developed by the project team will not only benefit the European machine tool industry – now very much concentrated in Germany – but also high-value manufacturing companies and their supply chains. In particular, it should enable the automotive and aerospace sectors to optimise their own processes: industries that are vital to the health of the UK economy.

Aerospace and defence alone are worth £55 billion a year to UK Plc and support more than 240,000 jobs. The automotive industry – ranking among the most productive facilities in the world – accounts for 12 per cent of UK exports, and has a turnover of close to £80 billion a year supporting 814,000 jobs.

A key part of the project is to explore how digital technologies (sensors and data analytics) can be exploited to improve machine tool performance. Currently, software packages tend to focus on a single feature related to a machine tool or machining process.

What is needed – and what Twin Control is delivering – is a much more holistic approach that covers machine tool kinematic and dynamic behaviour, CNC control and machining process. "We are finding that the combination of models

and process monitoring is proving really useful, not only in the development and design stages, but mainly during the production stage where it enables the operator to check that production is running smoothly, detect wear and tear without needing to halt production, and to predict component failure and other disruptions," said Erdem.

He believes the project will reduce the time taken to get machines working as designed (a 10 per cent time and cost reduction). It will also reduce the time it takes to get the process working as designed (a 20 per cent time and cost reduction). This is because the new simulation and control tools will allow a faster set-up of production processes at the end-user site. Precise estimations of part accuracy and additional features, including lifecycle, will allow an optimisation of process and machine parameters prior to implementation in plant.

In addition, Twin Control research will drive a step change in right-first-time manufacturing as the developed simulation tool will integrate different aspects that affect machining performance. This approach enables machine tool dynamics, control and the machining process to be integrated, allowing a more accurate prediction of the part quality compared to current single feature focused simulation tools.

It is also anticipated that the project will help the machine tool industry reduce energy consumption by between 25 and 50 per cent, as the new tools will define energetic optimal machine configurations by improved criteria for component selection. The simulation models will be combined with real-time monitored data from the machines to

detect unexpected energy flows and perform preventive actions during real processing.

Finally, the new model should improve machine reliability and increase machine up-time due to a proactive maintenance by a factor of five per cent. The exact knowledge of how each component will work enables a very accurate estimation of their end of life. This capability, combined with the results of machine tool testing procedure, the real component end-life and maintenance action historical data obtained through the fleet-based data management will lead to a more efficient maintenance strategy.

The success of the project does not mean that Frederick Taylor's problem of chatter has been silenced. On the contrary, the development of ever more sophisticated tools and processes is throwing down new gauntlets to machining dynamics researchers like Erdem.

"Virtual machining can help us understand the problem of chatter on power skiving, which is still very little understood and could be of huge value to the aerospace industry," says Erdem, as he prepares to follow once more in the footsteps of Taylor and Budak.

For more information:

twincontrol.eu
@twin_control



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 680725.

On the verge of massive disruption

In a wide ranging discussion, Paul Haimes – PTC’s vice-president of technical sales in Europe – talks to AMRC full stack developer, Jonathan Eyre, about digital twins, immersive technologies and the massive disruptive change that is coming to the workplace of the future.

JE: So what is a digital twin?

PH: A digital twin is a connected representation of a physical asset, that could be a product, could be the factory, but the important thing is that it is connected and streaming information about what is taking place. A digital twin is not just a piece of CAD software with a model in it representing what is going on; an electronic representation is not a digital twin.

JE: Within your description, you mentioned the connection is critical; what does this mean to you in terms of how quick does a feed need to be to be real-time and up-to-date?

PH: The important point here on connectivity is the device, the asset, has the ability to capture its own performance with whatever functions it is doing. Then it needs to have the ability to record and persist that information

somewhere. Now that could be in the form of an edge device, or some edge compute layer, is then managing that information and discarding what is unnecessary, but then filtering and working and distributing only what is important.

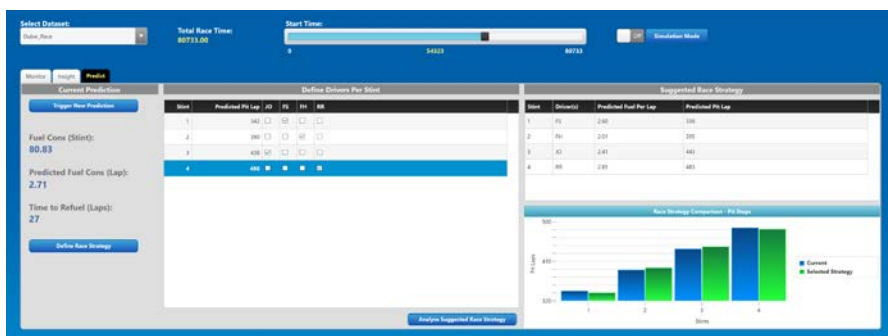
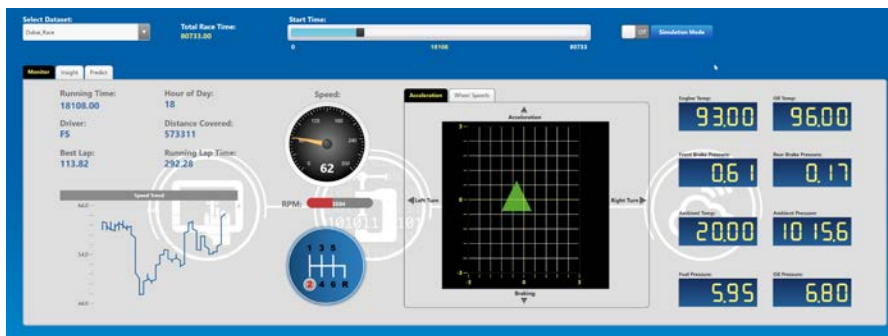
The data from the connected asset is being persisted somewhere. It could be historian, it could be a spreadsheet, could be a device cloud, could be a SQL database, but the important thing is it’s going somewhere and the data being stored is being turned into information at some point in its life. This could be real time or something done as part of a batch process.

JE: So stored information about something that physically exists, and then re-run that to form a visual about what it was doing previously, would you define that as a digital twin?

PH: How far the digital twin term extends is an interesting point. For me it’s the way you act on information. If you take for example an analytics model, a predictive maintenance perhaps, that digital twin information if it is being monitored and assessed against a predictive model then for me that is forming part of a digital twin: data coming in is being acted upon in real-time against a known behaviour that leads to a particular outcome. Digital twin has to extend simply beyond just gathering data, ones and zeros; it is about what you do with it. If you are just gathering data, you might think you have a digital twin, but you could have just spent a great deal of money that is probably not going to deliver a great deal of value back into the company.

JE: So here you mentioned value; what do you deem to be the best value? Do you see it being more in design, simulation around real-time or maintenance and repair?

PH: That is the million dollar question and it’s always going to be different depending on the company you are talking to. When it comes to digital twin, the most common reference is when it comes to maintenance and keeping assets running. For example, we are just doing some work with a forging company that has connected one of its forging lines that historically failed every three to four months. In that instance, through connecting the line and not having any machine learning ability here, the operators learned to understand the signals and the feeds coming off the line to the point where they were then able to spot where problems were developing with the clutch. They were then able to proactively fix the issue before a failure happened just in time rather than after the case. That is now saving them



A Digital Twin dashboard demonstrator, built using historical data to generate insights into and predict physical asset performance.



around \$200,000 a year because that line has now been running for nine months without any failure.

JE: The first example with the forging company, from what you have described, is a monitoring application with data connected to a visualisation of that information. Do you describe this as a digital twin?

PH: I do, I think it's the value of the digital twin. If we go back to the real-time understanding of how the product is being used you're feeding that information, you are then feeding this into the engineering environment so if the engineers have access to the dashboards that allow them to see what is going on with the products they are designing, they might have a requirements list that they are working on, but the insight that the digital twin provides allows them to validate redundant parts to reduce the number of

“ It is that vision of machine learning around the spotting of patterns **goes way beyond what a human could possibly do** to understand the intricacies of what is happening on the line. ”

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requirements or constraints of a system. When thinking about the app generation of today where we want them focused on purely what we want them to do is now filtering down into the way we interact with things such as mobility, vehicles, household appliances, anything we make and touch. Consumers want the simplistic approach to the way in which they interact with products. Steve Jobs said ‘simplicity is the ultimate complexity’ and what he meant was making something the easiest to use is actually quite complex and difficult, but certainly we see a shift in the way people are interacting with devices.

JE: If you think back to the SCADA systems with HMIs showing cells running at a factory level with real-time connectivity, would you classify that as a digital twin system?

PH: I would, seeing the data and seeing what is going on is useful but most importantly it is how you act on it that makes the difference. They have been around a long time and have been used to good effect to be able to react to issues on the line perhaps more quickly, but what we are talking about with Industry 4.0 is the ability to predict rather than react. It is that vision of machine learning around the spotting of patterns goes way beyond what a human could possibly do to understand the intricacies of what is happening on the line. Then of course on top of this you have the connected worker with augmented reality to then maintain it and that in theory offers benefits in reduced time to solve particular issues

on the line form an integral part of digital twins.

JE: With all what we have discussed in mind, how do immersive technologies fit into this picture?

PH: That’s a good question. I’m going to give you a high-level answer to this question because of the number of connected devices on this planet is going to explode and the sheer amount of data that then needs to be processed, turned into something valuable, but then delivered back to the user. This all stems to why we bought Vuforia, why we continue to aggressive develop AR capability is the value that is derived from all this data still needs to be delivered back to the human and the fastest, most digestible way to consume this digital information I believe will be through an augmented experience.

Our ability to have information streamed to us about things we need to know, I think we are on the verge of some hugely disruptive phase, where at some point, somebody is going to come out with something useful in terms of eyewear that is un-intrusive, cool from a consumer point of view, safe to use in an industrial context and all of that together with things like GPS locations and GEO-fencing.

I see it as something that will explode in the next five years or as soon as a device comes around that is capable of delivering that. The data will be streamed us based on our location, based on our role within the business, based on consumer buying habits from our general lives and so forth. All of that will explode in terms of the way we

consume information.

JE: My last point is, are digital twins going to be universal for everyone or have to be highly configurable viewports for users?

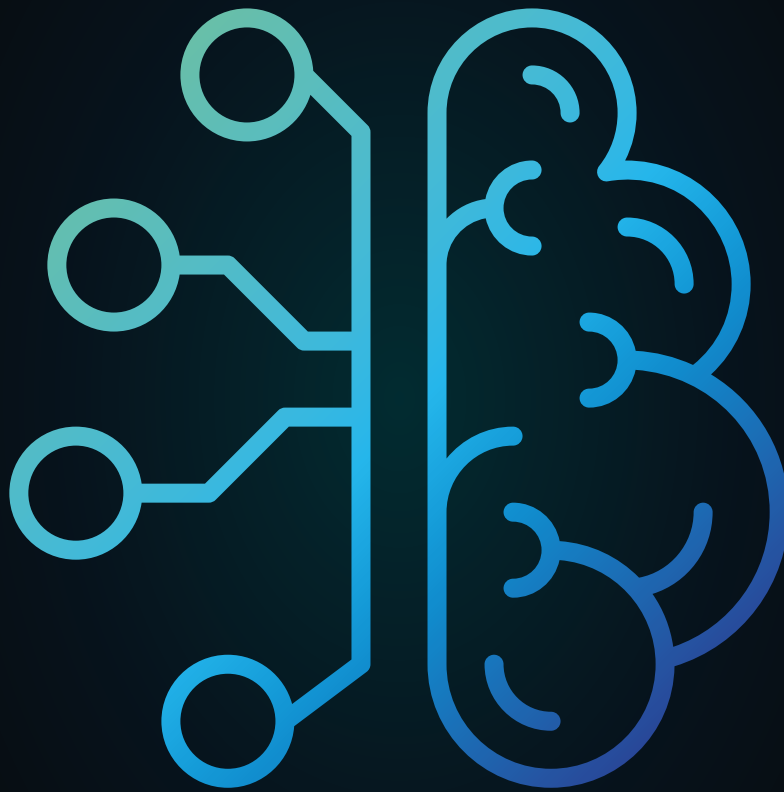
PH: I think it has to be role based, it’s part of the value of the digital twin is that you are gathering vast amounts of information about your connected assets and that information is valuable to different people in different ways.

If we talk about that connected factory, for instance the forging company we mentioned earlier, we have the CEO and directors that have their dashboard view of what is happening on their shop floor lines. They want to be able to see all the relevant information at a high level, such as the overall equipment effectiveness (OEE) of the assets as don’t need to see the temperatures of the furnaces, they just care about what is making them money on the shop floor.

This goes all the way down to the engineers on the shop floor who need the information relevant to them in the area they are working, which can’t be the one size fits all for these two examples.

The value in which we are talking about is the way in which we condition data so it becomes valuable for the user. It comes back to Steve Jobs with ‘simplicity is the ultimate complexity’, the way in which we are able to condition data to deliver what is necessary is one of the key points of the Fourth Industrial Revolution that we are rattling towards now is about providing just that.





Intelligent machining

The research skills of our machining engineers are critical to the AMRC's reputation as the go-to-place for some of the most demanding, high-value manufacturing companies on the planet. John Yates talks to the Machining Group's Head of Research, Tom McLeay and Professor Mahdi Mahfouf, about the digital revolution in manufacturing.

Tom McLeay is discussing data informatics with Professor Mahdi Mahfouf. Within the first few minutes the conversation has ranged from Galileo – 'measure what is measurable, and make measurable what is not so' – through to Einstein's views on insanity.

Mahfouf argues that if we reverse Einstein's famous aphorism – 'insanity is doing the same thing over and over again and expecting different results' – we get a neat description of what can happen when manufacturing relies too heavily on imperfect models.

"Data, like measurement, has been taken too much for granted," says the Algerian-born academic, who has earned an international reputation for

developing 'fuzzy algorithms' for use in modelling and control in advanced manufacturing and healthcare.

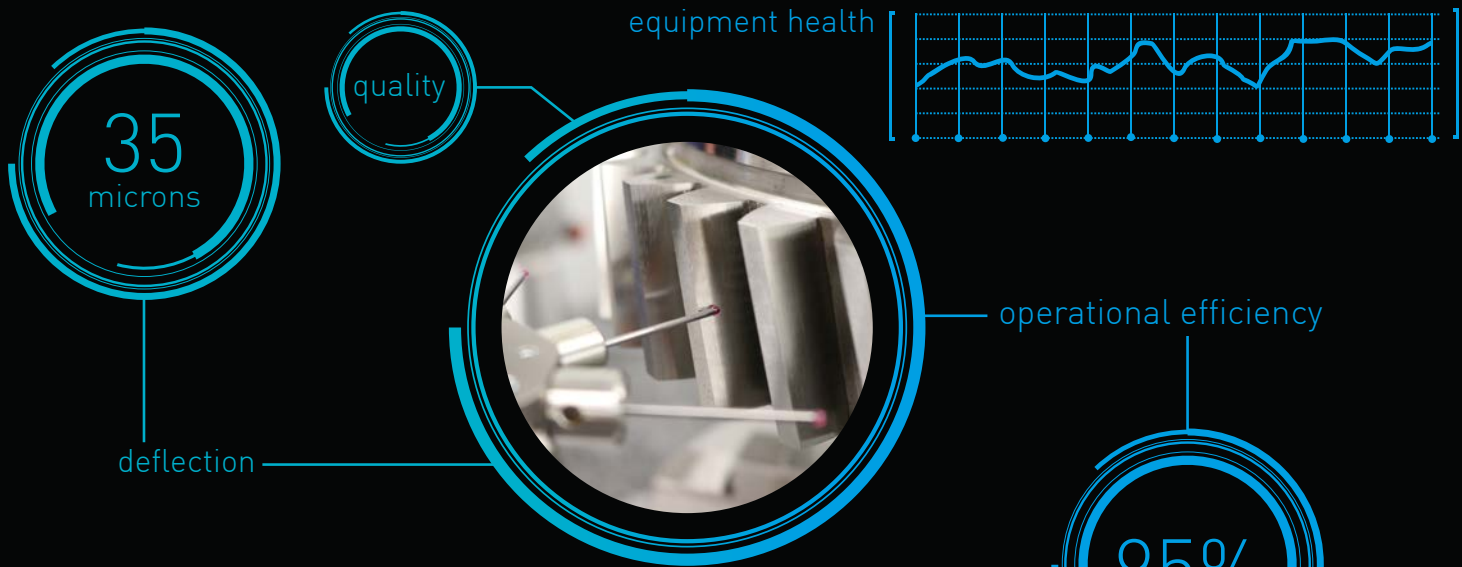
He and Tom meet regularly as members of the EPSRC funded Future Advanced Metrology Hub whose goal is "to create ground-breaking embedded metrology and universal metrology informatics systems' that can be applied across the manufacturing value chain. The project aims to 'effect a paradigm shift in measurement technologies, embedded sensors and instrumentation and metrology solutions.'

Mahfouf and McLeay are all too aware that manufacturing is evolving through disruptive technologies towards a goal of autonomous production, with

manufacturing value-chains increasingly digitised. "Future factories will have to be faster, more responsive and closer to customers as manufacturing is driven towards mass customisation of lower-cost products on demand," say McLeay. And metrology is crucial to this digital shift as it underpins quality, productivity and efficiency gains under these new manufacturing paradigms.

Which brings us back to Einstein and insanity. What if the models currently used to guide production processes contain flaws based on the inclusion of poor or misleading data? Is industry right to think these models will continue to deliver a good result over and over again. Not at all, says Mahfouf, in fact, the

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results could be disastrous.

“People seem to think that big data is all about volume; but it is much more complex and multidimensional than that,” says Mahfouf, a leading researcher in the University of Sheffield’s Faculty of Engineering, who was invited to become part of the Future Metrology Hub by Dame Xiangqian (Jane) Jiang at the University of Huddersfield.

If successful, the Hub’s metrology data analytics will create a smart knowledge system that unifies metrology language, understanding, and usage between design, production and verification. Such a system will be able to extract maximum information from measurement data, conduct a complete verification of the product in-process, and as required, dynamically re-design the process and even product itself in light of this information.

“Our role is to help integrate cyber physical systems, including data modelling, optimisation, control processes and such with the ultimate aim of achieving right first time production. The big question is how to use data informatics to ensure you get something right without having to go back and re-do it again?” says Mahfouf.

So just how close are we to this Holy Grail of right first time production? Here the fuzzy logician hands over to precision engineer McLeay. “We are still at the early stages of development to achieve right first time in high-value manufacturing. Most part and process behaviours are too complex to precisely predict as environmental and operational effects interfere with our predictions. We want to demonstrate that more accurate predictions can be

made by using live, data driven models to describe the true behaviour of our manufacturing system. We can already relate information in our metrology data to the judgments that an expert makes, but a rationalised metrology system, taking the right measurements, at the right time, in-process, is now needed to make this cost-effective in production.”

McLeay is convinced that the Hub will develop a new generation of metrology technologies, methods and capabilities that are essential to the creation of future digital, flexible, reconfigurable and autonomous factories. “The outputs will include new sensors and instruments that greatly extend the applications of embedded metrology, and new software solutions to embed metrology across the manufacturing value-chain,” he said.

This will create the essential link between design, manufacture and verification, as well as developing methods for data extraction and analysis that will enable exploitation of the exponentially growing big data that embedded metrology will create. New understanding and methods will drive and inform future education and training programmes and develop new international standards for application across a wide range of manufacturing industries.

“All of these outputs will be enablers for improvements in manufacturing performance, efficiency and quality as metrology is integrated across the manufacturing value-chain. The widespread adoption of new manufacturing related processes and technologies being developed across the research and innovation landscape – such as additive/hybrid manufacture,

large area electronics, automation, novel materials – will also be greatly enhanced and accelerated as a result of these outputs,” he added.

The choice of the AMRC as a key partner in the Hub is based both on the close links we have with Huddersfield and also the role we are now playing in shaping the contours of the Fourth Industrial Revolution. AMRC Executive Dean, Professor Keith Ridgway, said: “Metrology, distributed data capture and analytics are at the heart of the AMRC vision for flexible, reconfigurable and digital manufacturing as embodied in our new Factory 2050 facility. Our role as an innovation spoke coupled with the Department of Automatic Control and Systems Engineering’s role in the manufacturing informatics spoke complements the core capability of the team in Huddersfield and builds upon a very strong relationship between the two groups.

“The digital and interconnected nature of Factory 2050, make it the ideal canvas for the metrology informatics spoke providing the infrastructure, the machines, the processes and the data to demonstrate the technology created within the spokes. The facility will provide an SME to OEM accessible platform for industrial engagement with the hub and as a UK flagship for I4.0. Inspired by the Manufacturing Foresight report this is a perfect melting pot for Catapult, industry and EPSRC domains to come together and build the digital factory.”

Canadian company AV&R partner with the AMRC to explore the future of automated visual inspection

The concept for a new automated visual inspection system that uses robotics to manipulate metallic components is being tested at the AMRC.

Rebecca Ferguson reports.

Canadian automation, machine vision, and robotics solutions specialist AV&R is working with the AMRC to develop the new system in a simulated industrial environment, proving out the technology and de-risking any potential investment for end users.

The AMRC's Integrated Manufacturing Group (IMG) are conducting trials of the AV&R system, which is deployed at Factory 2050 thanks to funding from the High Value Manufacturing Catapult.

Automated visual inspection refers to the automatic detection and classification of defects using robotics, for high-value complex metallic components.

IMG Senior Project Engineer, Harry Burroughes, said: "Visual quality inspection processes are vital in industrial sectors such as aerospace and medical; where the assurance of high-quality is essential for a complex component to meet expected performance levels."

The AV&R system uses a robot to handle a component lit from various angles,

and rotates it in front of a camera so the system can acquire photometric data about the component surface.

Engineers are configuring the system to collect significant data about AV&R's testing process to optimise the set-up so the system can be used for bespoke inspection processes and be verified for use on multiple components across various industrial sectors. The team will also create a 'digital twin' that will assist operators and aid remote assistance for preventative maintenance.

Strategic Partnerships Manager of AV&R Aerospace, Philippe Masson, said: "The system focuses on the inspection of small surface defects, with our main market being within aerospace inspection processes.

"Our new capability of inspecting different type of parts was the catalyst for discussions with the AMRC about future automated visual inspection tests which could be performed on high-value components. Together, we are exploring latest technologies for a human operator to review the machine's results with



Inside the automated visual inspection system.

augmented reality."

Harry Burroughes, who is working on the project for AV&R, said: "Through our trials of the system we will process various configurations of photometric data which will be translated and presented to the user of the system through various digital representations for user-friendliness.

"The development of this system will make quality testing more efficient, more repeatable and allow manufacturers to increase their testing capacity, speeding up the overall manufacturing process for complex components.

"This will allow the AMRC to extend our research and increase our capability for advanced visual inspection techniques for complex components used in many high-value manufacturing sectors," he added.

AV&R is keen to stay ahead of the curve when it comes to the development of new technologies and achieves this by investing in research and development; partnering with research centres. Philippe Masson said: "What is interesting about the AMRC is that as a member we have access to their networks and industrial contacts, this means we will be able to work together to understand how our system can be developed to best serve the requirements of inspection processes in other industrial sectors.

"The work we do with the AMRC will allow us to gain valuable feedback and data from the use of the system to inform and share with our customers on the reliability and performance. It will be a valuable benefit to be able to disseminate information backed by a world-renowned organisation, one with a well-known reputation."



L-R: Harry Burroughes with Jean-François DuPont and Philippe Masson of AV&R at AMRC Factory 2050 where the automated visual inspection system is installed.

A new reality on tap for Yorkshire Water

Ageing water treatment works and pumping stations across Yorkshire could be replaced by new equipment developed with the help of interactive, virtual reality models created by researchers at the AMRC, **saving Yorkshire Water £1m a year in prototyping costs alone and significantly reducing its environmental and carbon impact.**

In the past, the company has had to build expensive real-life prototypes of any new equipment, which could take weeks and months to engineer. Modifications to these prototypes would often be difficult and costly to carry out, and all the models would ultimately end up as scrap in a “graveyard of prototypes” which is both wasteful and inefficient.

Now, with the help of advanced visualisation experts at the AMRC, four prototypes – which would have cost £180,000 to build using traditional methods – have been developed using Visionary Render technology at a fraction of the cost and time.

“These are significant savings in terms of cost and time,” says, DfMA Development Engineer at Yorkshire Water, Martin Rowe. “If we extrapolate that, we would save at least £1 million a year on the costs of prototypes alone. And there are so many other benefits.”

These include reduced environmental impact (the prototypes no longer have to be scrapped); improved health, safety and ergonomics (using the immersive

models to engage occupational health experts, operatives and maintenance engineers to quickly identify and change potential hazards at the design stage); increased use of off-site manufacture to ensure the build is right first time; the creation of powerful training tools; and, ultimately, the collection and analysis of real time data for more efficient operation and maintenance.

A launch of the new technology at Yorkshire Water’s Leeds headquarters, showed just how versatile Visionary Render can be. “The AMRC has built us not just one pumping unit, but a whole site that includes seven different models,” says Rowe. In this case, the site is the Irton water treatment works near Scarborough which was originally built in the 1880s, but is now getting a £17.5 million upgrade by Yorkshire Water.

“A full site model would have been impossible using the old approach,” says, Manager of Standard Products and Solutions at Yorkshire Water, Steve Wright and the man spearheading the digital revolution at the company. “What we now have is a totally immersive

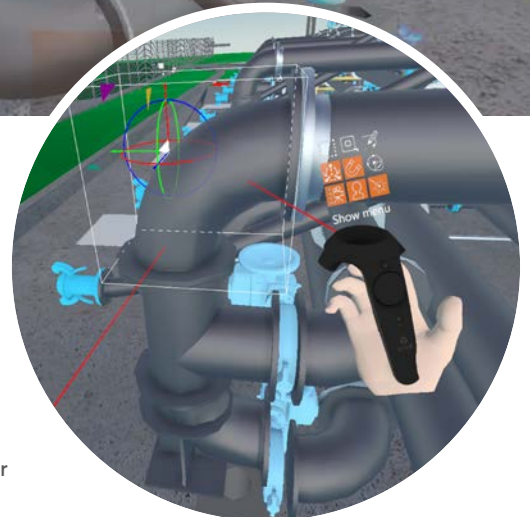
experience that enables us to check all the interfaces; to check that everything fits where it is supposed to fit before it goes on site; to ensure that safety and efficiency are fully integrated into the design, to give our operators and maintenance engineers a plant that is easy to run.”

For both Wright and Rowe, VR also fits perfectly with Yorkshire Water’s ambition to move towards a more cost-effective, modular off-site manufacture. “Our goal is to find more efficient ways of working; of getting more with less. VR can help us standardise and build offsite. This enables us to reduce health and safety risks – a clean, controlled, factory environment is a better working environment than a building site. It also improves our quality assurance processes, drives improvements in productivity, and enables us to reduce our carbon footprint by getting it right first time with equipment that has been functionally tested and is ready to plug in and go,” says Wright.

Unlike current Building Information Modelling (BIM), Wright believes that:

The VR model of Irton water treatment works.





“VR is a brilliant way of communicating with all our stakeholders, providing an instantly recognisable visual experience that enables them to not only understand the design, but also to contribute to making it more efficient and effective. It takes a technical drawing and converts it into a powerful, immersive experience,” says Wright.

“Only last week we used the model to stand on top of a tank 30 metres in the air. We felt like we were suffering from vertigo even though we were in the virtual world – and all had that we had for safety was a small rail. That led us to think we needed something more substantial and the design was changed in an instant – much more efficient and effective than having to put the things right on site.”

For AMRC Technical Lead Mike Lewis and his colleague Steve Forte, the Yorkshire Water project has been a fast-turnaround effort. “Yorkshire Water came to us with a standard product catalogue he is developing and wanted to know how advanced visualisation systems could support that effort by removing the need for building expensive prototypes,” says Mike.

He and the team at the Integrated

Manufacturing Group wanted a tool that would provide Yorkshire Water with a powerful, fully immersive system for ergonomic design review. Drawing on their experience of the fast moving VR market, and their partnerships with market leaders in the field, Visionary Render was identified as an ideal candidate.

“Virtalis are well known to us and their product is incredibly versatile and robust. It allows us to move quickly from raw, native CAD data directly into an immersive VR environment,” said Mike. A quick test on four single models, was followed by something more challenging. “By building a site-wide model we could test the system to its limits to see how it held up. The success of the site-wide demonstrator gives us absolute confidence it is fit for purpose.”

The AMRC is now working with Yorkshire Water and its supply chain partners to move from its more traditional CAD-based models to a fully immersive system, and then to do this on site with their engineers to ensure complete transfer of knowledge, which will include a comprehensive report that details all the processes.

“At the end of this project, Yorkshire

Water will have the equipment and the skills to be able to do this themselves,” Mike said. “From there, we could work with them on more advanced systems, pulling in real-time data from sites that improve productivity and maintenance regimes. We could also develop augmented reality training systems, including health and safety that take the same assets and use them to upskill the Yorkshire Water workforce of the future. We could even use our visualisation techniques to make the most of BIM. This bundle of digital measures could unlock much more substantial savings for Yorkshire Water – the benefits of which could be passed on to consumers.”

Yorkshire entrepreneur raising the roof with new construction aid tested by AMRC

A retired builder-turned-entrepreneur has invented and patented a brand new method of joining roof battens which will not only improve construction safety, but make a roof quicker and easier to assemble than the traditional method.

Rebecca Ferguson reports.

The KEAH Roof Batten Joints have been tested and verified for use at the University of Sheffield AMRC's Advanced Structural Testing Centre (ASTC) after KEAH director Ken Johnson worked with the team there due to their ability to create bespoke testing systems and procedures at the UKAS accredited facility.

Ken, from Leeds, who is 70 years old, spent the majority of his career as a builder and developer in the construction industry. After retiring from his construction businesses, he felt driven to put his own ideas formulated through his vast wealth of experience on building sites, into action to improve construction processes.

Ken created a new company, KEAH, to bring those ideas to life starting with the innovative Plastic Pipe Chamfer and now the ground-breaking new roofing aid which is completely manufactured in Yorkshire.

The Roof Batten Joint is a plastic injection-moulded, push-fit 'joint' to easily connect horizontal wooden roof battens at any point along a roof structure, instead of needing to trim them to size and nail them to the vertical roofing spas.

"After working in construction all my life and having first-hand experience of the issues that can cause delays and cost resources on site, I thought there must be a smarter way to complete those time-consuming intensive manual jobs," said Ken Johnson.

"The KEAH Roof Batten Joint can join two roof battens at any point on the roof which will save time and material waste. The joints make felting and lathing a roof quicker, but also safer and stronger than the usual methods as they eliminate weakening of the roof structure from trimming and patching battens that can lead to split batten

ends and joint failure," he added.

The ASTC has tested the batten joints to destruction using a bespoke testing technique. This includes strength testing 28 configurations of the batten joints using a Moog control system and the ASTC's own 'Tall Rig'.

Phil Spiers, Head of the ASTC, said: "KEAH constructed a roofing model that fits perfectly into our Tall Rig. The rig was developed during project work with Sheffield-based Gripple UK, and has the capability to conduct longer and more accurate tests for a variety of purposes.

"We applied loads to the KEAH joints using the rig until failure of the roof batten, noted the mode of failure and the maximum load achieved just prior to failure. Compared to the traditional joint the KEAH joints were capable of carrying an extra 10 stone on average.

"Our tests have so far shown that the joints are stronger than traditional nailed roof batten fixtures and experience lower rates of failure. We have validated that the optimum load weight for use is 20 stone, but the joints can support all the way up to 50 stone in weight."



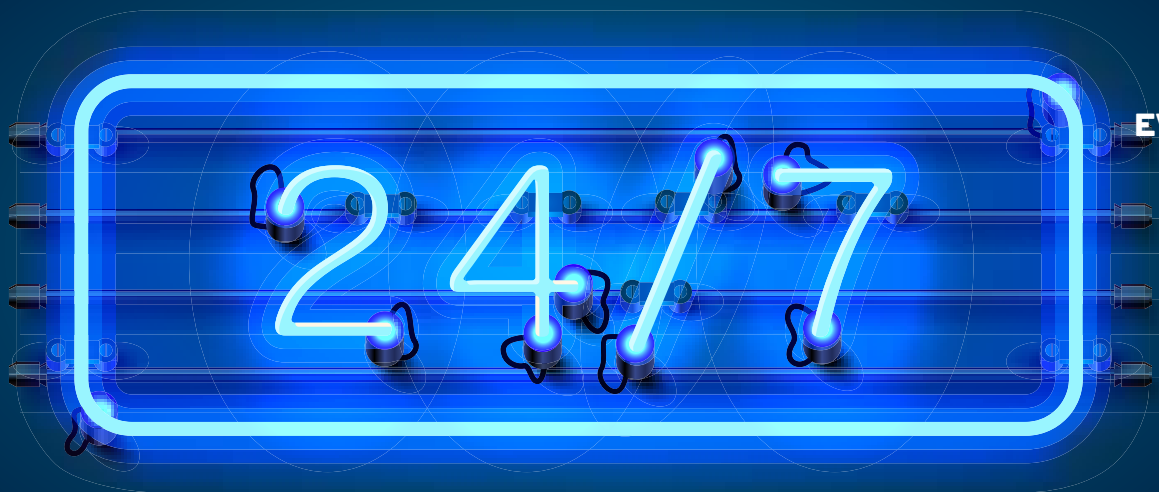
L-R: Head of the ASTC at the AMRC, Phil Spiers, KEAH General Manager Emma Johnson, AMRC Technical Lead for Structural Testing Shane Smith and KEAH Director Ken Johnson.

"The idea for the product itself is beautifully simple, but it is a powerful concept that will make a laborious task safer," added Phil Spiers.

KEAH has already developed the product through a series of prototypes and is working closely with national construction and roofing companies to ensure the product meets the needs of those keen to get their hands on the new technology.

The company benefited from SME grant funding through the High Value Manufacturing Catapult to pay up to 50 per cent of the costs for the testing.

"For a small company such as ours, it really helps us get this pioneering roofing product off the ground. The testing is invaluable as it means we will now be able to approach our potential end users and confidently state the load bearing weights of our product and that the joints are ready to go into production thanks to the AMRC," said Ken Johnson.



Lights out running and factory automation

Increasing numbers of businesses have ambitions to run their operations unmanned overnight or into the weekend. With the potential for increased output and reduced costs, how realistic is it to run automated operations with the lights out?

The AMRC Forum in March discussed the experiences of SMEs and large companies who have implemented these strategies, as well as those who provide the technologies.

Rolls-Royce Machining Specialist, Simon Dutton, kicked off proceedings by discussing the ideal state for effective 'lights out' running and factory automation, which was for manufacturing processes to be adaptive to change and run without intervention.

For this to happen he said manufacturers must start by defining the optimum characteristics and parameters for a method of manufacture: "To be able to work towards standardisation you must have similar methods of manufacturing that track throughout the whole manufacturing process. The aim is to manufacture similar commodities on the same machine platforms; that is the challenge that Rolls-Royce aims to tackle, with standardisation our goal for the future."

Senior Applications Engineer at Geo Kingsbury, Scott Smith, agreed that planning ahead is the key to manufacturing precision and quality: "For precision manufacturing in a lights-out factory environment, identify anything that would be a problem throughout the process. The entire manufacturing process relies on accuracy, so understanding all the cycles allows the formulation of on-machine solutions and the reduction of

human error."

Mandy Ridgeyard, owner of experts in flight control components and assemblies, Produmax, said that improving productivity was the driving force behind increasing investment in innovation and technology, but businesses cannot solely invest in assets for automation in isolation.

With automation, Produmax have cut lead times from 31 days to 21 hours, turnover is up by 55 per cent and the headcount at the company is up by 60 per cent. Mandy said that integrating autonomous processes successfully goes hand-in-hand with supporting cultural change within an organisation to embed new working practices effectively:

"It is key for a business to understand the mix of people they employ to be able to best support them and prioritise their strengths. We introduced a range of development options, such as apprenticeships, higher educational and graduate learning and we celebrate staff achievements.

"We need to help people understand the processes needed for the introduction of automation and to encourage flexibility in working processes to empower staff to make, engage and create change is essential, ultimately placing human intelligence at the centre of your leadership vision."

ABB Product Line Manager, Matt Rollins, told the audience that one of



the key things to consider when going down the automation route is the culture of the organisation: "You need to engage and inform everyone at an early stage: production staff, maintenance department and management. Tell them why the changes are being made and how people will be affected. In the end, it doesn't matter how well the automation works or how short the robot's cycle time is if the operator isn't fully committed to the project."

This view was echoed by the Jon Stammers, the AMRC's Process, Monitoring and Control Tech Fellow, who said that automation would never replace the human element. He said: "No computer is as clever as a person, and one of the things we need to capture when we are collecting data is the experience of the operative." He looked at the factory, machine and process implications of digital, and how monitoring at different levels can provide data that can be turned into knowledge. "Analysis can be as simple as real-time go/no go decisions using in process measurement and health checks. More in depth analysis, however, can yield great process insights," he said. Correlating data enables comparisons to be made between machine health results and in-process measurements; and between spindle vibration, in-line lubricant monitoring and final part inspection. The future, he argued, could see more use of big data to support predictive analysis.

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