

quarterly journal

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**Advanced Manufacturing
Research Centre**



New challenges create **opportunities for growth**

TRAM Conference

Renaissance predicted for metals in aerospace

Internet of Things

Don't delay, start developing today, say experts

Bloodhound SSC

AMRC and partners Maher come to rescue of record attempt



Advanced Manufacturing
Research Centre



Welcome to our quarterly journal

New manufacturing challenges offer opportunities for further growth

There have been several occasions since the AMRC was founded, almost 15 years ago, when we thought we might now have some time to consolidate.

Every time that has happened, new opportunities have opened up, opportunities we simply couldn't afford to let slip through our fingers.

The same is true today – as you will read in the pages of our latest Quarterly Journal.

Projects are underway inside Factory 2050, the UK's first fully reconfigurable assembly and component manufacturing facility, designed for collaborative research.

We have expanded our Training Centre and secured funding for the new part-time degree in manufacturing. We have launched a joint venture in Korea and are involved in talks that could lead to the AMRC brand being taken to other regions in the UK and other parts of the world.

Opportunities are opening up for further expansion on our new Advanced Manufacturing Campus.

At the same time, our existing operations are continuing to grow, taking on new challenges and widening our industrial client base dramatically, allowing us to compensate for any down turn in one sector.

Our turnover is growing and we have a full order book for the next 18 months.

But, we haven't lost sight of the fact that an organisation which has grown by 12 per cent a year from a small department employing 12 people into a group with 560 employees and a turnover approaching £50

million has to change in response to that phenomenal growth.

That is why, as you will read elsewhere, we have created a new corporate structure to take the AMRC to our next stage of development and have been joined by Colin Sirett, the former head of research for Airbus in the UK as chief executive officer of the AMRC with Boeing.

With Colin now in post and Mike Tynan, former CEO of Westinghouse, leading nuclear developments as CEO of the Nuclear AMRC we have a tremendous management team in place.

Recent surveys have shown manufacturing is facing a tough time in the UK – and that emphasises the need for organisations like the AMRC, which help manufacturers to become more competitive and productive.

With investment under pressure, it also emphasises the importance of organisations like the AMRC which can explore new technologies, ensuring that companies not only make the right investment decisions but also get the implementation right.

Despite, or perhaps because of, the challenges we face, new opportunities will keep opening up. We have to keep seizing them and pushing the boundaries of what is possible.

Prof Keith Ridgway, CBE.

Executive Dean of the University of Sheffield Advanced Manufacturing Research Centre





Micromachining seminar.
page 30

“ What we are seeing here is the manufacturing cradle of the future ”

George Osborne speaking at the AMRC, on the signing of the regional devolution deal.
page 28



contents

Partner News 4-7

AMRC News 8-11

Case Studies

Maintaining thermal distribution 12
when curing composites

AMRC and Maher come to the 13
rescue of World Land Speed
Record attempt

Event Reviews

TRAM UK 2015 14-23
Aerospace Conference

Internet of Things seminar 24-27

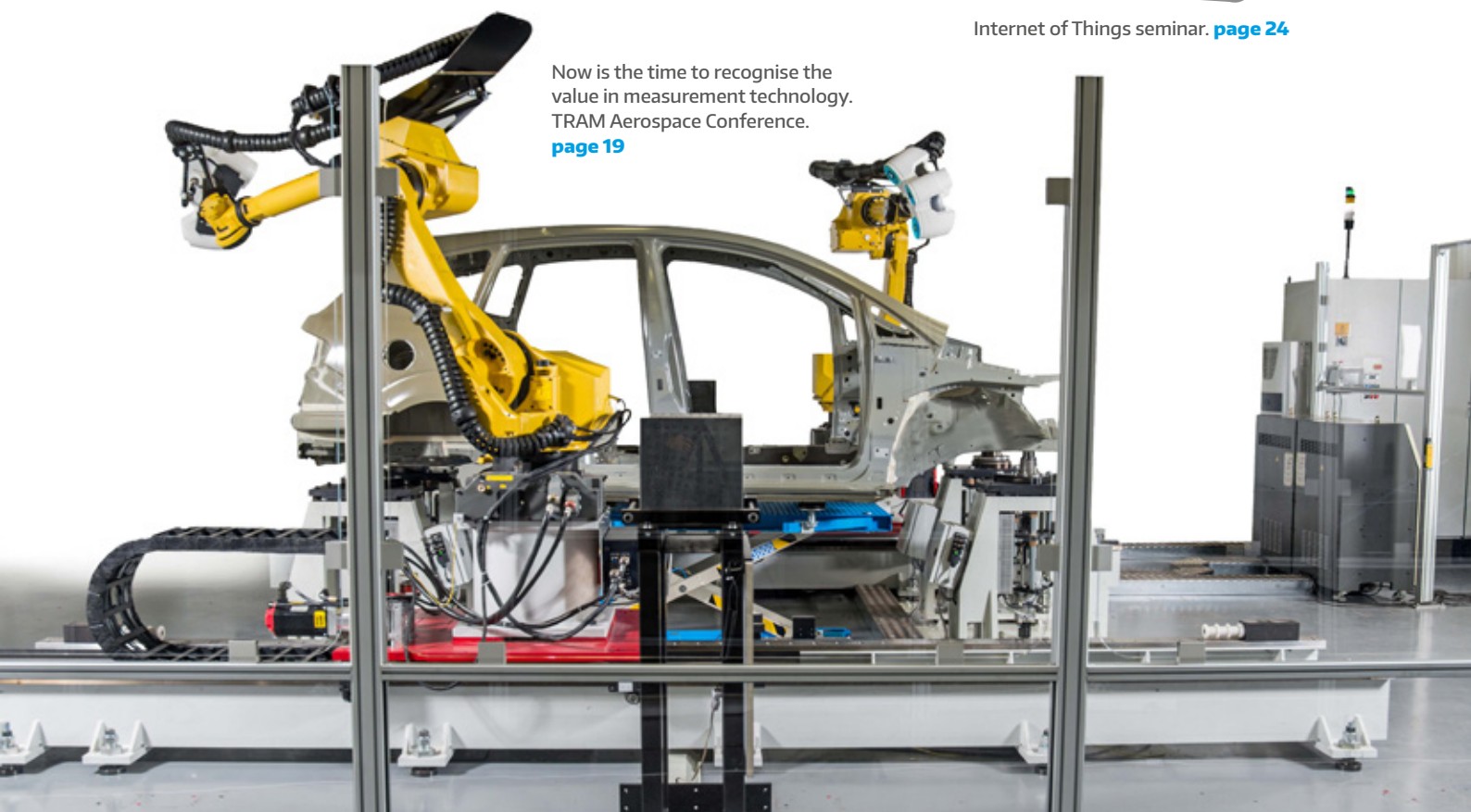
AMRC Tech Fellows 15 28-29
Partner Conference

Micromachining seminar 30-31



Internet of Things seminar. page 24

Now is the time to recognise the value in measurement technology. TRAM Aerospace Conference.
page 19





Tony Bowkett, second left, and Nikken Kosakuso Europe's apprentices, with leading figures from Nikken at the official opening



The new Nikken Kosakuso Innovation Centre at the Advanced Manufacturing Park (AMP)

Multimillion investment boosts drive to improve UK manufacturing competitiveness

A partnership that dates back to the founding of the University of Sheffield Advanced Manufacturing Research Centre is set to bear new fruit for UK companies, following a multimillion pound investment by Nikken Kosakuso Europe.



Tony Bowkett addresses the official opening of Nikken Kosakuso Europe's new centre

The company, which specialises in high accuracy tooling solutions, rotary tables and high precision setting and optimisation technologies for machine tools, was one of the first partners to back the embryonic AMRC when it was established at the start of the new Millennium.

Now, it has opened a new demonstration and customer support centre, the Nikken Innovation Centre Europe, packed with advanced equipment to help companies become more competitive by increasing production rates and quality while reducing costs.

A total of £4 million has been invested in the new development and the company plans to invest a further £3 million on a second phase of development by the middle of 2017.

The new development is Nikken's first research and development facility outside Japan and will complement facilities at the neighbouring AMRC. It will also be the headquarters for Nikken's UK operations and seven subsidiaries stretching from France to Sweden and Germany to Turkey and South Africa, which support customers in 28 different countries.

"Our partnership with the AMRC is a marriage made in heaven," says Tony Bowkett, group managing of Nikken Kosakuso Europe.

"We have been part of the AMRC from the outset. We share the same philosophy and the cross fertilisation between the two organisations is fantastic. We have a great collaboration and the AMRC is training our four apprentices, whose numbers we hope to increase to 10 over the next five years."

Like the AMRC, the company has invested in a range of machines similar to those used by existing and potential clients, who include companies working throughout the aerospace, high performance automotive and precision medical sectors.

Tony Bowkett says one of the key reasons for the development is companies are no longer willing to invest in new tool and workholding solutions based solely on what they read in a catalogue and what the supplier tells them.

Instead, they want the reassurance of seeing the technology used to make components similar to their own products on the machines which they themselves use.

Nikken has deliberately opted to invest in machines that complement, rather than replicate those at the AMRC, acquiring what is generally lighter weight equipment.

"You won't find a machine here that is in the AMRC," says Mr Bowkett. "The AMRC is free to use our machines and we can use theirs. It's a collaboration."

AMRC commercial director, Adrian Allen OBE, said: "We are pleased, proud and privileged to be associated with Nikken Kosakuso Europe – a business which Tony started in Rotherham and which is continuing to grow.

"His investment strategy broadens the scope of both our organisations to help manufactures increase competitiveness by taking advantage of the latest technologies, techniques and research.

"In addition to having customers in sectors like aerospace and space exploration, motorsport - including , Formula 1 - rail, offshore wind power and medical equipment, where we are also active, Nikken also supplies sectors where we don't have a presence.

"We look forward to continuing to help each other's clients."



ENERGY INDUSTRY SUPPLIER USES SIMULATION AND VR TO PLAN MAJOR GROWTH

Global energy industry supplier Hayward Tyler is aiming to double in size with the help of simulation and virtual reality (VR).

Hayward Tyler is a leading manufacturer of performance-critical, fluid-filled motors and pumps.

It has deployed Lanner's WITNESS, featuring the VR capabilities from AMRC partner and advanced visualisation leader Virtualis, to plan a business growth strategy which will see the company double the size of its flagship operations.

Hayward Tyler increased its turnover from £18 million in 2011 to £30 million in 2014.

It now wants to create a 10 year strategy with the aim of doubling the size of its Luton facility, while more than doubling the number of units produced there and ensuring the facility is fit for purpose.

The company needed to be able to fully

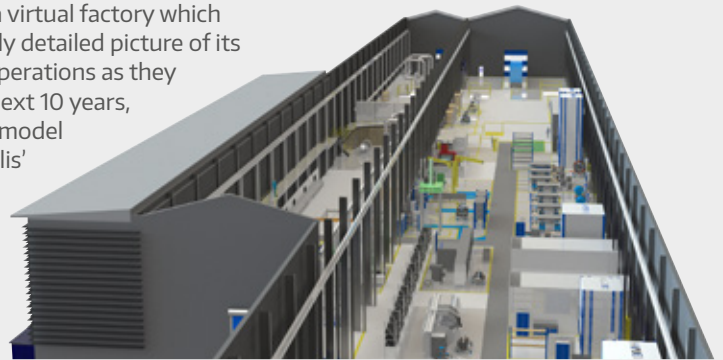
understand what opportunities would look like in 10 years, what the business would look like, and how it needed to evolve.

Factoring in so many complex and interconnected variables - including new equipment, new people, new sub-assembly processes, cranes, forklifts and back office processes - would have overwhelmed even the most experienced planner, so simulation was deemed crucial to achieve project goals.

Hayward Tyler used WITNESS to build a model to create a virtual factory which presented a highly detailed picture of its manufacturing operations as they evolve over the next 10 years, and brought the model to life using Virtualis' VR and 3D capabilities.

Manufacturing systems director Martin Clocherty said: "Thanks to the advanced immersive 3D capabilities, we can demonstrate our final factory layout to employees, internal and external stakeholders.

"Through bringing the future-state layout to life in this way, we can consider more alternatives, make better decisions, and most importantly better engage and motivate our employees, thus maximising the overall success of the project."



3D model of Hayward Tyler's expanded factory

INSPIRATION THROUGH INNOVATION EVENT'S POPULARITY MUSHROOMS

Seco Tools (UK) is celebrating the success of its 'Inspiration through Innovation' Open House advanced manufacturing best-practice event, which attracted more than 500 visitors.

The event took place at Seco's state-of-the-art Technology Centre in Alcester and was attended by manufacturers from Ireland as well as the UK.

Now in its second year Inspiration through Innovation provided an ideal venue for Seco to promote its own new, advanced and innovative cutting tools and its range of customer-focused services and process improvement solutions to visitors.

Guests showed particular interest in Seco's Custom Tool manufacturing operation which designs and manufactures bespoke cutting tool solutions in-house for customers.

Forty of Seco's technical partners, comprising leading machine tool builders and best-in-class CAD/CAM, work-holding, cutting fluids, automation and inspection and measurement specialist suppliers, took the opportunity to showcase their latest technologies at the event - up from 15 in the previous year.

Seco's sales and marketing manager, Mike Fleming, said the increase demonstrated that, over a relatively short period, Inspiration through Innovation had become "a 'must attend' event."

In addition to exhibits and a number of innovative machining and cutting demonstrations taking place throughout the two days, a series of short high-impact seminars covering a wide range of contemporary manufacturing issues and topics also helped pull in the crowds.

Specific seminars covered the latest trends in the automotive industry; advanced roughing strategies; productivity in machining (turning) steel; reducing vibration during machining operations, and best-practice machining of titanium; stainless steels and nickel-based alloys.

Richard Jelfs, Seco's managing director, said: "Our objective with Inspiration through Innovation is to create an event that is truly customer-focused and that demonstrates to visitors and partners alike that significant improvements in productivity and performance are best achieved through collaboration and by sharing best practice.

"The feedback from this year's event, from visitors, technical partners and the media demonstrates that we achieved this objective and, certainly as far as visitor numbers were concerned, we exceeded our own expectations."



Plain sailing for castings experts as they meet marine sector's titanium challenge

Castings Technology International (Cti) is pursuing new opportunities in the luxury and performance yacht market after helping a top marine propulsion specialist create what is believed to be the first four blade folding propeller made from titanium.

Bruntons Propellers' Varifold designs are used on luxury motor yachts and have blades that fold inwards, to reduce drag when the yachts are under sail, rather than engine power.

The propellers are usually made from aluminium bronze, so when a client asked if titanium could be used to save weight on a high performance superyacht, Bruntons approached Cti, operators of the UK's only commercial titanium casting facility.

"Titanium offers a number of advantages," says Cti's Anthony Kenney.

"There are considerable weight savings over aluminium bronze. Titanium has superior resistance to corrosion in salt water and sea organisms, including creatures like barnacles, are repelled by the metal, so maintenance costs are lower.

The advantages don't end there.

Expensive wooden patterns have to be made to create the sand mould for an aluminium bronze propeller blade casting and castings have to be made oversized to avoid problems associated with traditional casting processes, which means up to eight millimetres of excess metal has to be machined off all of a blade's surfaces and features.

Cti's technology uses data taken directly from computer aided design drawings to make 'Quickcast[®]' patterns on a 3D printer and produces a near net shape casting, which needs only minimal post cast processing to enable the end user to achieve the correct component geometry.

"There are no initial tooling costs, which is particularly advantageous if you are making just one or only a few castings and hard tooling can be made later if the number of castings needed increases," says Kenney.

Titanium's high strength to weight ratio and corrosion resistance means it is widely used in the aerospace and oil and gas sectors, however, Kenney believes there could be increasing applications for using the metal to make a range of components for higher value luxury and performance marine markets.

Making castings from titanium isn't without its challenges. The metal is highly reactive when liquid which means melting and casting must take place under vacuum and special expertise is needed when designing the moulds for the casting and choosing the refractory materials they are made from.



Bruntons' four-bladed, titanium, Varifold propeller.

Cti has built that expertise up over a number of years and is currently developing the capability to melt and pour up to 1,000 kg of titanium at a time.

Based on the knowledge the company obtained during the initial manufacture of the propeller blades for Bruntons, Anthony Kenney believes Cti should be able to cut lead times for titanium marine components by up to 30 per cent in future for similar products, further increasing its capability to compete with producers in continental Europe.

Bruntons' product manager, David Sheppard, said: "Bruntons is often asked to design and manufacture propellers or complete propulsion systems for yachts where the currently available options just will not do.

"Our collaboration with Cti was very successful and resulted in a weight saving of between 40 and 50 kilos on a 36 inch Varifold propeller. All our range of two, three and four bladed Varifold propellers will now be available in titanium, giving any racing sailing yacht an additional competitive edge."



Renishaw announces new non-contact vision probe for the REVO® multi-sensor system

Global measurement, motion control, spectroscopy and precision machining group Renishaw has launched a new vision measurement probe (RVP) for use with its REVO® 5-axis measurement system on co-ordinate measuring machines (CMMs).

RVP increases the multi-sensor capability of REVO-2 by adding non-contact inspection to the system's existing touch-trigger, high-speed tactile scanning and surface finish measurement capabilities.

Non-contact inspection provides clear advantages over traditional tactile probing techniques for certain applications.

Thin sheet metal parts or components with large numbers of holes as small as 0.5 mm and parts which are not suited to tactile measurement can be fully inspected with the RVP system. RVP also gives exceptional improvements



in throughput and CMM capability by using the 5-axis motion and infinite positioning provided by the REVO-2 head.

The RVP system comprises a probe and a range of modules that can be interchanged automatically with all other probe options available for REVO-2. Data from multiple sensors is automatically referenced to a common datum. This flexibility means that the optimum tool can be selected to inspect a wide range of features, all on one CMM platform.

Part illumination is provided by

integrated programmable LED lighting inside each module. Background feature enhancement is also available using backlighting combined with bespoke part fixturing.

The RVP system is managed by the same I++ DME compliant interface as REVO-2 and full user functionality is provided by Renishaw's MODUSTM metrology software. New MODUS vision software capability includes RVP configuration, image processing with application specific options and automatic image storage for review and further analysis.

Craftsman Tools' quick change tool holding system chosen to join UK export showcase

Craftsman Tools' Coromant Capto® quick change tool holding system has been nominated to join a prestigious hall of fame for key British exports.

Craftsman Tools is a multi-award winning supplier of precision toolholding, workholding and supply chain management services to a broad spectrum of the engineering sector with over 60 years' experience.

Its ground breaking Coromant Capto® is the first universal quick-change tooling system suitable for turning, milling, boring and drilling and is the result of an ongoing collaboration with Sandvik Coromant, a world leader in tooling, which has created an extensive range of products.

Combining Coromant Capto® toolholders with modern machine tools shortens set

up times and leads to enhanced accuracy, improved productivity and great cost savings; offering manufacturers an extensive range of benefits.

The success of the Coromant Capto® has been highlighted by the 'Exported by Britain' campaign, which is run by the All-Party Parliamentary Manufacturing Group and the Design and Innovation Group; a cross-party coalition of Parliamentarians and manufacturing industry organisations.

The campaign highlights the diversity and prevalence of exporting from across the UK by inviting MPs to nominate products from the manufacturing and creative industries sectors that are exported from their constituencies.



By so doing it challenges the myth that the UK no longer exports to the rest of the world.

Craftsman exports 80 per cent of its output worldwide and has developed a new range of toolholders suitable for delivering high pressure coolant directly through the cutting tip of static tools, to maximise the full benefit of recent advances in machine tool designs.

This range enables significant improvements to be made to cutting efficiency and reduces production costs.

Craftsman says it will be expanding its product range to meet the requirements of all the major machine tool manufacturers.



Major changes as fast growing research centre plans for further expansion at home and abroad

The AMRC with Boeing is gearing up for further growth at home and abroad, unveiling a new corporate structure and appointing a high-flying chief executive officer.

Colin Sirett head of research for Airbus in the UK and a long-time supporter of the work of the AMRC took over as CEO at the start of February.

Following his appointment, executive dean Prof Keith Ridgway, CBE, commercial director Adrian Allen, OBE, and projects director, John Baragwanath, OBE, have become executive directors of the AMRC Group.

The group spans all of the 560 employees, £50 million turnover operations of the AMRC with Boeing and the Nuclear AMRC, the AMRC Training Centre, the AMRC Knowledge Transfer Centre, AMRC Castings and Cti Ltd.

Prof Ridgway said: "Colin Sirett will be a tremendous asset for the AMRC.

He shares the AMRC's aims and ambitions and understands our culture.

"He has already made a major contribution to our success, not least as a key member of the team that helped Messier Dowty win the order to supply the landing gear for the Boeing 787, which was a critical event in the formation and growth of the AMRC.

"As executive directors of the AMRC Group, Adrian, John and myself will focus on developing the AMRC brand, expanding the AMRC in new locations and developing major new initiatives."

In addition to being head of research for Airbus in the UK, Colin Sirett is chairman of the National Composites Centre steering board and deputy chairman of the Aerospace Technology Institute Technology Advisory Group. He is a Fellow of the Royal Aeronautical Society and sits on the Learned Society Board.



Colin Sirett, The AMRC with Boeing's new CEO

Prior to becoming director of research for Airbus, he was head of the landing gear product delivery team for the A350XWB Programme.

Colin Sirett said: "The AMRC has grown over the last 14 years by delivering technology and productivity impacts direct into global industries. This growth will continue, and it is an honour and privilege to be part of steering the enterprise through its next chapter, and ensuring the next generation of engineers are an intrinsic part of that growth."

Inaugural AMRC team member named Professor of Machining Practice and Chief Technical Officer

One of the founding researchers from the AMRC with Boeing has been appointed Professor of Machining Practice at the age of 41.

Sam Turner's appointment came not long after he was named the AMRC's chief technical officer.

Prof Turner said: "It's a great honour and it comes at an exciting time when big opportunities are opening up around digital manufacturing.

"I see our Factory 2050 development as the UK flagship for digital manufacturing and my role as CTO as enabling and delivering high impact projects that change the UK's manufacturing infrastructure and support the sector's growth.

"I want to ensure the AMRC is recognised as the place to come to for state of the art manufacturing science, bringing new technology through the

development pipeline that will improve productivity and help both existing companies and the start-ups that I believe will come out of the AMRC environment."

Prof Turner joined the AMRC at its start, after studying Mechanical Engineering with French Language in Sheffield and Grenoble and gaining industrial experience with Thomas Turton & Sons, in Chesterfield, where he set up a new machine shop and modernised its heat treatment facilities.

He became the inaugural member of the AMRC machining group – which now numbers 85 people and has been a key contributor to the AMRC group's growth into an organisation.

Prof Turner sees a key part of his role at the AMRC as ensuring its cutting edge research leads to tangible benefits for industry.



Sam Turner, chief technical officer, The AMRC with Boeing

"I have always been passionate about the idea of advancing the state of the art by applying research and by using what we discover to solve problems," says Prof Turner.

"A fundamental part of my new role will be making sure we get the right research, using the right technology to get the balance right and maintain the AMRC as the hub for machining and manufacturing research, working with the best companies, the best universities and the best staff."



CNC marking breakthrough to speed production, cut waste and free up workshop space

World leading component marking, identification and traceability specialist Pryor Marking Technology has unveiled a new technological breakthrough – with help from the AMRC.

The company spotted a gap in the market when several customers asked if it was possible to mark components using the same CNC machine that made them, instead of having to transfer them to special marking stations.

“Moving parts around the shop floor is the biggest cause of scrappage and waste in many manufacturing environments,” says Pryor’s sales director, Alastair Morris.

“A tool that eliminated the need to move machined parts to a separate workstation would significantly reduce the risk of damage and free up workshop space, but there weren’t any on the market.”

Although Pryor is at the forefront of marking technology, its understanding of how CNC machine tools are controlled was limited, so it contacted the AMRC for help.

The AMRC invited Pryor to its headquarters in Catcliffe, Rotherham, where Michael Garrett, a project engineer, with the AMRC’s Integrated Manufacturing Group, provided the advice they needed.

“We’re here to help companies large and small and are glad to see that result in innovations that will play a role in improving manufacturing processes and reducing waste,” says Michael Garrett.

Alastair Morris explains what happened at the AMRC: “We looked at the different CNC systems, the connectors they use and the common issues they face with tools.

“We also discussed the problems you encounter if you try to mark a component with a standard CNC tool.”

Armed with that information, Pryor developed a battery powered, wirelessly controlled dot peen marker that could be stored alongside other tools in the CNC machine and selected when needed.

“Once we’d built a prototype, we took it back to the AMRC for testing in their



new Mazak machining centre,” says Alastair Morris.

“The test was a success, so we’ve now filed a patent application and are about to launch our new CNC Marking Tool on the global market.”

Pryor’s CNC Marking Tool produces human or machine readable, two dimensional inscriptions that meet strict international aerospace marking standards.

It can be controlled wirelessly from a Windows computer, using Pryor’s standard software, which can vary the force produced by the marking head, allowing it to mark materials of different hardness.

AMRC testing expertise helps airport infrastructure specialist secure international approvals

Experts from the AMRC have helped a UK manufacturer hit tight deadlines after it won a prestigious order from the Middle East.

Cavotec UK makes a range of safety critical products, including special covers for airport manholes and service ducts, which have to withstand the weight of fully laden commercial jets.

The company sought the help of the AMRC’s Advanced Structural Testing Centre when it was having difficulty finding anyone in the UK able to test and validate the performance of the larger size airport utility access chamber covers it was developing.

To make matters worse, testing had to be completed within tight deadlines to gain the global approval it needed to secure an order for a major airport in the Middle East.

“It was quite a challenge,” said AMRC head of Advanced Structural Testing, Phil Spiers.

“We had to design and create a special machine from scratch, which could exert maximum loads of up to 200 tonnes on a small area of covers that could be up to six feet long by four feet wide.

“We used local companies to make heavy duty columns and a cross beam capable of being mounted on our 10 metre square flexible strong floor and holding the 2MN (2 mega newton) actuator applying the load.

“Once the test rig was built, we had to install sensors to measure the deflection when the load was applied to the covers and ensure they returned to their original state when the load was removed – and, we had to do all that within five weeks.”



Since completing the initial testing the Advanced Structural Testing Centre has been working with Cavotec as the company develops new designs and manufacturing methods to ensure it continues to meet stringent international airport safety standards.

For more information on Cavotec UK, visit www.cavotec.co.uk



Property Award prize secures places for jobless young people at the AMRC Training Centre

Small businesses are being offered help to recruit and train jobless youngsters to become skilled engineering workers, through the AMRC Training Centre

The Centre's new 'Flexible Apprenticeship Programme' starts in March and is tailored to meet the needs of small businesses.

Youngsters who secure a place on the programme will receive intensive masterclasses designed to get them work-ready within a business as quickly as possible and the same high-quality training as other apprentices on existing programmes.

The new initiative will offer eight places part-funded for the first year by a £30,000 award fund, set up by Advanced Manufacturing Park developer Harworth Estates and Sheffield Business Park after they won the Lambert Smith Hampton Enterprise Award with an entry submitted on behalf of the Sheffield City Region

Advanced Manufacturing Innovation District (AMID) partnership.

The fund will enable local young people who are not in education, employment or training, to get apprenticeships with local advanced manufacturers that are start-ups or small firms that have not recruited an apprentice within the last 12 months.

AMRC Training Centre programme manager, Daniel Swift, said: "From the very beginning the apprentices will be contributing to a business's growth and performance, as the new flexible programme allows apprentices to be with their employer for several weeks at a time in between training."

Iain Thomson, partnerships manager at Harworth Estates, said "Developing future talent for small businesses is the only way we'll achieve sustainable economic growth for the region and both Harworth Estates and Sheffield Business Park are delighted with the programme that the AMRC Training



(l to r) Iain Thomson, partnerships manager at Harworth Estates and Graham Sadler, managing director at Sheffield Business Park

Centre has developed for this purpose."

Graham Sadler, managing director at Sheffield Business Park, added "It is incredibly important that we have sufficient people from this region with the right skills to take jobs in growing sectors."

Companies can apply for the uniquely funded scheme via the AMRC Training Centre website at www.amrctraining.co.uk

AMRC becomes the first UK research organisation to join the Augmented Reality for Enterprise Alliance

The AMRC is demonstrating its leadership role in UK manufacturing by being the first UK research organisation to join the Augmented Reality for Enterprise Alliance (AREA).

AREA is the only global, member-driven organisation focusing on accelerating augmented reality (AR) adoption in enterprise. The AREA's mission is to help organisations achieve greater operational efficiencies through the introduction and adoption of interoperable AR-enabled enterprise systems.

By building on its current research into the impact and value AR within manufacturing, the Integrated Manufacturing Group (IMG) at the AMRC is well placed to advance the AREA's goals.

Chris Freeman, head of digital assisted assembly at IMG, said: "Joining the AREA will allow us to conduct core research projects with AREA members, assisting

them in creating tailored industrial applications and guiding industry in successfully adopting this advanced technology, all whilst evidencing measurable returns on investment."

AR will play a pivotal role in IMG's new home, Factory 2050, allowing them to showcase the developments and real value of AR to their network of industrial partners.

"At Factory 2050 we will be developing innovative ways to visualise the vast array of 'big data' available to manufacturing organisations," Freeman added. "Through the combination of wearable technology and analytics, Factory 2050 will help us demonstrate how digital information will be intelligently accessible and improve overall performance as part of a digital shop floor."

Christine Perey, AREA Executive Director said: "The AREA is very proud to welcome the AMRC as a member - our first dedicated to maturing AR for

manufacturing environments."

"Having a member dedicated to maturing these advanced technologies is important to the achievement of our organisation's strategic goals to drive continuous improvements and increase the impact of AR in industry."



Head of digitally assisted assembly at the AMRC's IMG group, Chris Freeman, demonstrating Google Glass.



AMRC launches Factory 2050

cutting edge advanced manufacturing research facility in Sheffield

The AMRC with Boeing has taken possession of Factory 2050, the revolutionary, glass-walled “reconfigurable factory” at the heart of the University of Sheffield’s new advanced manufacturing campus on Sheffield Business Park.

AMRC executive dean, Professor Keith Ridgway CBE, said: “We aim to make Factory 2050 the most advanced factory in the world, built to carry out collaborative research.

“It has been designed to ensure the UK’s advanced manufacturing supply chain can access the expertise it needs to make the most of new challenges and opportunities, and that our region retains its international lead in high value manufacturing.”

Factory 2050 will be home to the AMRC’s Integrated Manufacturing Group (IMG), which is installing the cutting edge manufacturing and assembly technologies, advanced robotics, flexible automation, next generation man-machine interfaces and new programming and training tools that will drive its research.

Initial projects include a programme to take aerospace manufacturing technology into the construction

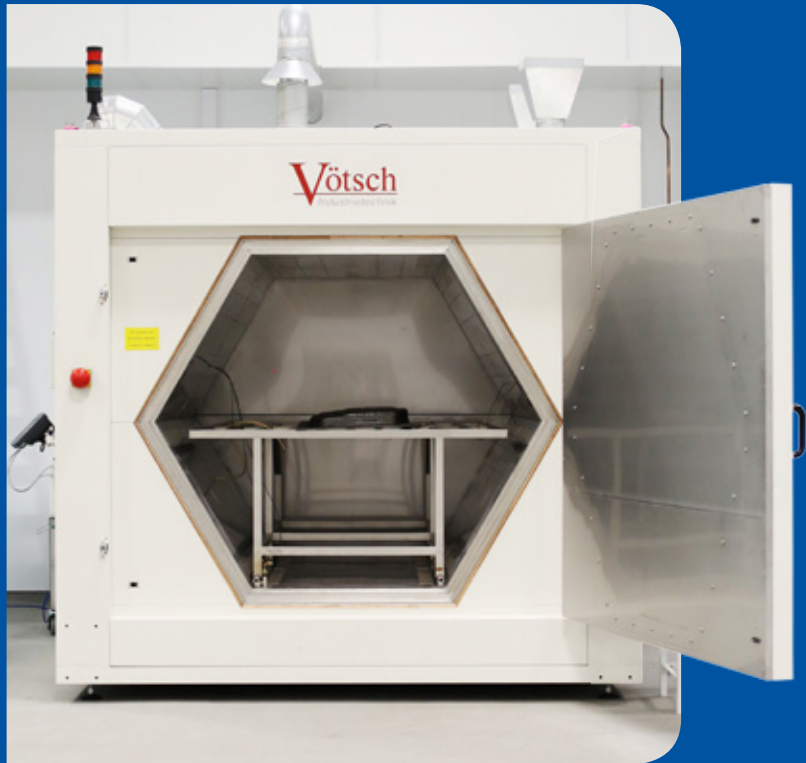
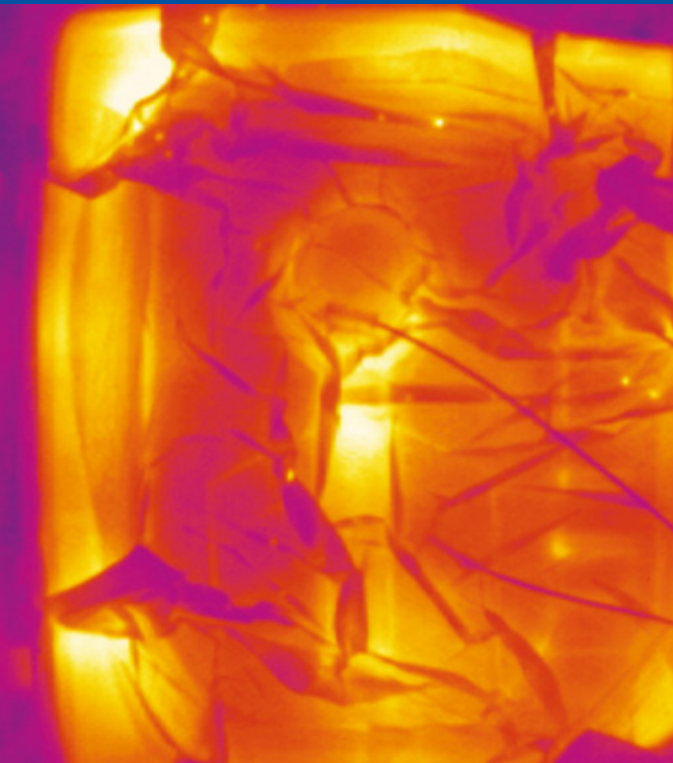
“ ...designed to ensure the UK’s advanced manufacturing supply chain can access the expertise it needs

Professor Keith Ridgway CBE ”

industry, explore future digital factory technologies for building commercial aeroplanes and investigate digitally assisted assembly technologies which could help to fill a looming skills gap in the aerospace sector.

Installing equipment will take several months and Factory 2050 is expected to be fully operational by summer 2016.





MONITORING THERMAL DISTRIBUTION WHEN CURING COMPOSITES

The AMRC with Boeing Composite Centre is extending its expertise in the production and machining of composite components, including hybrid parts which combine high-performance metals and composites in a single structure.



Identifying the opportunity to expand its capabilities for monitoring thermal distribution when curing composites in its industrial Vötsch microwave oven – the HEPHAISTOS VHM 180/200, the Composites group invested in a second Optris infrared (IR) thermal imaging camera, which has now been fitted to the microwave system.

Previously, the microwave hosted one IR camera for the purpose of sensing temperatures in the area of the chamber that initial trials were taking place. As the microwave capabilities have expanded, the team is now utilising the full chamber and requires more comprehensive visibility.

The second camera was installed with enhanced software to merge images from both cameras; enabling the team to gain a complete view of the chamber in real time, with no compromise on sensor capability.

The reliability and consistency of the microwave process is enhanced through the coupling of metallic and fibre optic thermocouples with the thermal imaging system.

The combination of these temperature monitoring systems can effectively detect hotspots or unequal thermal distribution, which can dramatically affect the integrity of the curing process on complex, larger components.

As the cameras were integrated directly into the microwave, they also act as a unique safety feature. The cameras can detect possible fires, and if the temperature inside the microwave exceeds safe levels they are programmed to provide warnings, with the ability to shut down the microwave if needed.

The AMRC Composite Centre are leading in the field of curing composite materials and its upgraded imaging capabilities will facilitate the team in defining and accelerating the research into microwave curing as a manufacturing process for industrial implementation.



AMRC and Maher come to the rescue of World Land Speed Record attempt

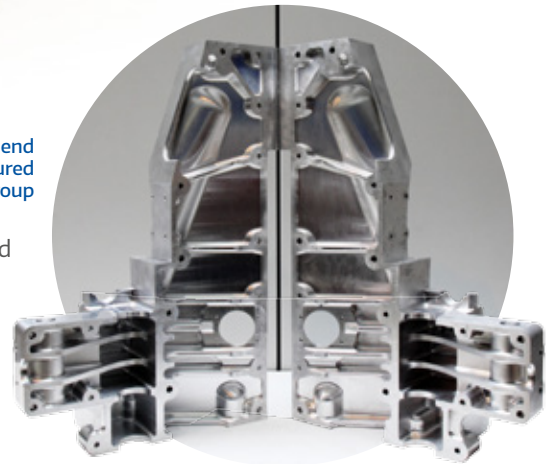


The University of Sheffield Advanced Manufacturing Research Centre (AMRC) with Boeing has joined forces with high performance alloy supplier Maher to help solve a problem threatening attempts to raise the Outright World Land Speed Record to over 1000 miles an hour.



Image: Flock and Siemens

Bloodhound front end assembly manufactured within the AMRC Group



RAF fighter pilot Andy Green hopes to use a combination of jet and rocket power to smash his existing 763mph record in Bloodhound SSC, the supersonic car that is the brainchild of British record breaker Richard Noble.

The project hit seemingly intractable problems when the material performance needs for the shaft and nut components for the rocket pump exceeded anything freely available to Bloodhound.

Bloodhound uses a 550bhp supercharged Jaguar engine to drive the pump, which has to be able to supply 800 litres of High Test Peroxide (HTP) to the rocket in just 20 seconds – the equivalent of 40 litres or more than nine gallons every second.

The shaft and nut linking the engine to the pump has to be made of stainless steel to prevent the HTP reacting before it reaches the rocket, The pump was performing better than expected but with the increased performance came an increased load which the standard stainless material simply couldn't cope with.

The AMRC has already made and tested a number of complex key components in support of Bloodhound and its rocket development programme.

When its head of advanced structural testing, Phil Spiers, heard about the problems, he immediately thought of a new alloy, developed for aerospace applications.

Phil contacted AMRC partner Maher, the Sheffield-based stockholder that supplies high strength, high performance alloys for demanding applications in sectors that include aerospace, oil and gas exploration and power generation, as well as motorsport.

Maher was able to supply a sample of the material which tests showed was ideal for the pump application.

Phil Spiers said: "Bloodhound is simply an exciting and dynamic engineering challenge. One of its key aims is to capture the imagination of young people and encourage them to pursue careers in science, technology, engineering and maths.

"It's all about showing how engineering can solve problems and is the foundation for everything that we can do to improve the world for the people who live in it.

"Thanks to our awareness of the advanced materials that are being developed and Maher's willingness to help, Bloodhound has been able to overcome another hurdle in the way of a successful record attempt."

Donna Saul from Maher, based at Brightside Way, Sheffield, said: "We're proud of the products, services and quality we provide and committed to helping customers solve their toughest problems. Working with the AMRC to find a solution to keep Bloodhound on track was an ideal opportunity to show what we can do."



TRAM



UK 2015

AEROSPACE CONFERENCE

Success depends on having the skills to supplement advanced manufacturing investment and innovation



Adrian Allen,
commercial director,
The AMRC

Companies must be able to recruit individuals with the best brains and the right skills if they are to reap the benefits of investment and innovation, according to Adrian Allen.

The University of Sheffield Advanced Manufacturing Research Centre commercial director was welcoming more than 300 delegates, attending the Trends in Advanced Machining, Manufacturing and Materials Conference (TRAM), at the Magna Science Adventure Centre in Rotherham. "Success for all of us depends on getting the best brains back into our companies and, more importantly, keeping them there," said Allen.

He told delegates the AMRC was continuing to invest and was collaborating with local government on plans to create an Advanced Manufacturing Innovation District surrounding its Advanced Manufacturing Park and Factory 2050 developments.

"A big thrust of what we are doing at the AMRC is next generation manufacturing," said Allen, adding that part of that included training apprentices for industry and offering them the chance to continue on into higher education, with the support of their employers.

"We have 550 apprentices in place, every single one backed by industry, everyone going through an education, without taking debt on board," said Allen.

The first TRAM conference and exhibition was organised by the AMRC in 2009, since then it has taken place alongside the International Manufacturing Technology Show (IMTS) in Chicago.

TRAM's return to the UK was arranged by the University of Sheffield Advanced Manufacturing Research Centre, the Association for Manufacturing Technology, Gardner Business Media and the Royal Aeronautical Society.



Metal renaissance will follow the composite boom as aircraft construction starts a new cycle



Kevin Slattery, chief scientist for metals, ceramics and mechanical parts, Boeing Research & Technology

New materials, new processes and new structures made possible by additive manufacturing could herald a renaissance in the use of metals in aircraft construction, according to aerospace giant Boeing's Dr Kevin Slattery.

Boeing Research & Technology's chief scientist for metals, ceramics and mechanical parts predicted a swing back from composites as new metallic materials and processes were developed.

"We are going to continue to see improvements in aluminium alloys. There will be improved strength, stiffness and corrosion resistance," he told the conference.

"We are seeing improvements in joinability with processes like friction

stir welding. We see improvements in structural, fatigue and fracture analysis; improvements in machining capability that enable us to machine more complex, thinner components."

Reducing the number of components that needed to be fastened together would reduce the extra weight, risk of corrosion and non-continuous load paths inherent in fastened joints, improving the fit of components and reducing maintenance, inspection and testing requirements.

Additive manufacturing would enable more efficient construction, with structural analysis tools being used to determine where weight was needed, instead of the structure being driven by manufacturing processes.

Dr Slattery said these advances would not only affect the next generation of aircraft. Materials usage would reduce for the current generation, too. It would require less energy to build an aircraft and the 'buy to fly' ratio would go down.

The Boeing chief scientist said data transfer links between Tier 1 aerospace companies and their suppliers would become as important as shipping links.

The supply chain would act more like the vertically integrated air framers from aviation's early years, with data being transmitted and stored securely throughout the supply chain so that when parts arrived from a supplier, the recipient would be happy they were suitable to be installed.

Aerospace engineering's future will be additively manufactured

Additive manufacturing (AM) was a hot topic at this year's conference, with speakers discussing how it could create opportunities to innovate and arguing for the development of an overarching understanding of its processes if AM was to finally 'perform on demand'.

Defining the process was as crucial as controlling the structure and integrity of the material alloys if AM was to be taken seriously by aerospace manufacturers, said Professor Ian Todd, from The University of Sheffield.

Limited research in the public domain meant engineers lacked the knowledge needed to reduce redundancy, improve dimensional accuracy and manufacture support-free structures conforming to aerospace standards.

The University had achieved a 65 per cent reduction in micro cracks by studying the effect of thermal stress on alloys, their susceptibility to cracking and whether they can be modified.

However, more research into selective laser melting of difficult to machine

alloys, like nickel super alloys used in aerospace applications, was needed to make them easier to process and improve efficiency.

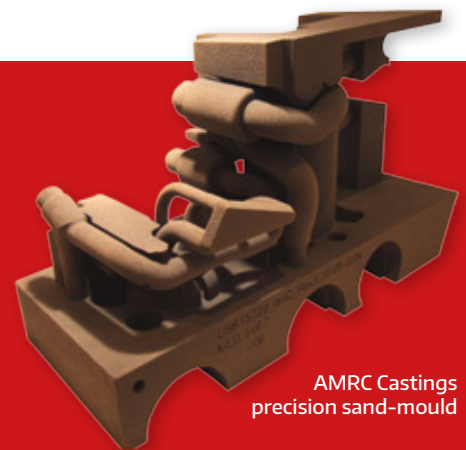
Ian Brooks, principle engineer for Moog Controls, said AM was useless without proper design rules.

Moog was working with technical partners, Renishaw, to develop AM machines capable of manufacturing components for aerospace applications and could see the technology being used for highly complex integrated assemblies such as civil aircraft flight controls, reducing weight, time, costs and CO₂ emissions.

The company was working on extreme mass reduction of components for large passenger aircraft, using AM to achieve a 48 per cent reduction at part level and 24 per cent at assembly level.

Richard Gould, from AMRC Castings, said AM was revolutionising the castings industry, enabling more complex and near net shape castings to be made.

AMRC Castings uses AM principles to



AMRC Castings precision sand-mould

develop and optimise processes and keep castings technology at the leading edge of design and production.

Combining 3D and additive layer manufacturing (ALM) technologies allowed design processes to be optimised, reducing product design cycles and enabling functional castings that meet aerospace requirements to be produced rapidly.

AMRC Castings had used AM technologies to further develop its large scale ceramic mould and precision sand-moulding castings processes, reducing the weight of gas turbine engine components by up to 34 per cent, increasing engine performance by 1.5 per cent and saving 21 million passenger miles in CO₂ alone, said Gould.



Producers seek better classification system for powdered metals as demand rises

Robert Smith-Graham, vice president for powder products at Carpenter Technology Corporation

The growing potential for additive manufacturing (AM) in the aerospace sector and the continuing expansion of powder metallurgy technologies is increasing pressure for developing ways of classifying the powders they produce.

Robert Smith-Graham, vice president for powder products at Carpenter Technology Corporation told the TRAM conference that differing technologies produce powders with different characteristics and a fuller understanding of those characteristics was important for future development.

Titanium presents particular challenges because of the reactivity of the metal, but, whatever the metal, the size, shape and flow, along with cleanliness and the presence of residual gasses in the

powder can all impact how it can be used.

Some technologies produce particles that range in shape and size, said Smith-Graham. Smaller particles made using technologies that don't employ a vacuum tend to contain more oxygen and nitrogen content can also be a problem.

Particle size affects spreadability and flow, although some non-flowing powders can work well for additive manufacturing.

Meanwhile, powder that is recovered and recycled by the AM process tends to be higher in particle size and oxygen content.

"Maybe a process can live with some degree of recycling – or maybe it cannot



accept that at all," said Smith-Graham, adding that parameters for the powder tended to be determined by the AM machine that was being used.

"We have done a lot of work with research organisations and universities to develop standards, but further, different characterisation methods need to be developed that can better enable us to classify powders and better understand other effects," he concluded.



Advanced manufacturing conference gets a sneak preview of new Jaguar

More than 300 delegates attending the global metalworking industry's premier aerospace conference got a sneak preview of Jaguar's new F PACE when it arrived at Rotherham's Magna Science Adventure Centre.

The vehicle, which is being made in the UK, isn't due to be launched until later this year, but a pre-production version of the eagerly awaited F PACE was in town as part of the TRAM conference.

AMRC commercial director, Adrian Allen, said: "TRAM not only gives companies in the aerospace supply chain a vital insight into developing technologies, it has also given this region a chance to showcase the skills and capabilities that make it a world leader for advanced manufacturing and will help to attract

more valuable business to this region and the UK.

"The presence of the F PACE demonstrated how the continuing development of advanced manufacturing technologies is helping to keep UK companies at the global forefront – a process which we at the AMRC are delighted to be able to play a significant part in assisting."

The F PACE was just one example of the applications of leading edge technologies unveiled at the conference, which organisers hope will lead to new alliances being forged that could bring major economic benefits.

Speakers at the event included Jaguar Land Rover group powertrain

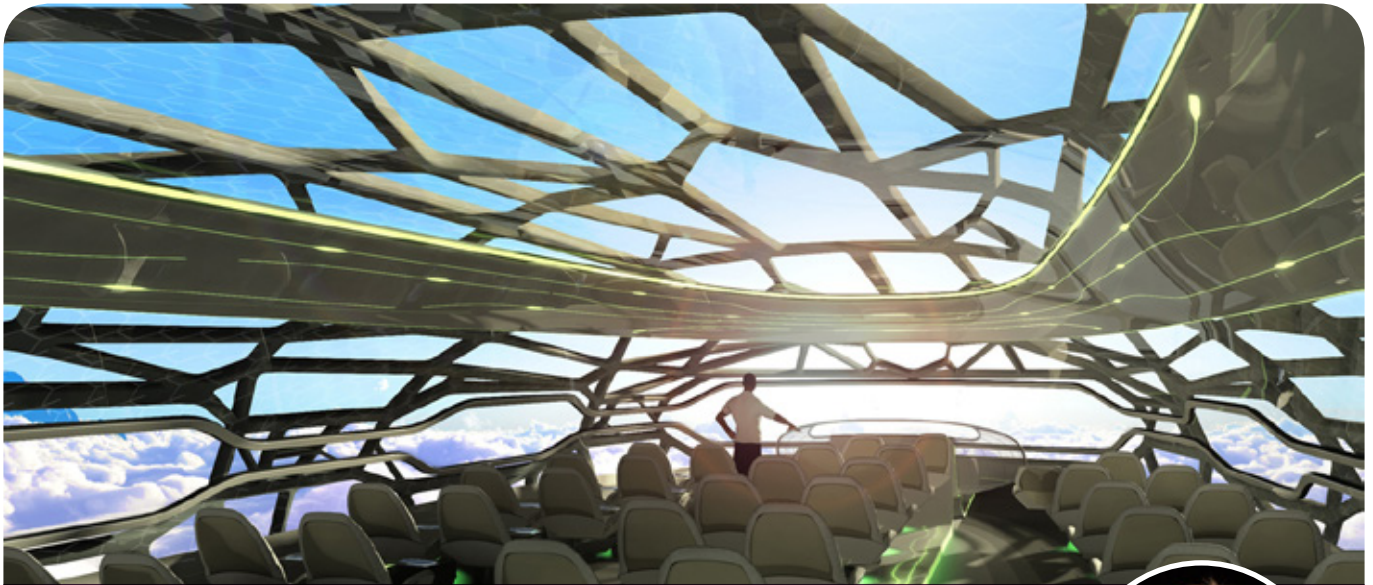
operations director Nigel Blenkinsop.

He told delegates how Jaguar Land Rover had responded to a series of challenges when it decided to develop a new engine plant in the UK, not least the fact that it had not built an engine for 18 years.

"Simplicity is the key when you are trying to create something from scratch," said Blenkinsop.

"We created an aligned organisation with accountability and common sets of objectives, focused on operational excellence. We recruited over 1,000 new employees and put a significant focus on the creation of apprenticeships to create a workforce that is sustainable for the long term."

Above: Pictured outside Magna with the pre-production model of Jaguar's F PACE are (l-r) AMRC commercial director Adrian Allen, Jaguar Land Rover operations director Nigel Blenkinsop and Magna's chief executive, John Silker.



'Bionic design' will lead to great gains from the manufacturing efficiencies that 3D printing will bring



Axel Flaig, head of research and technology for Airbus SAS

How should aerospace manufacturers be responding to future aviation challenges?

Traffic in the skies is set to double in the next 15 years and aerospace manufacturers will need to put into service a further 32,585 aircraft in the next 20 years if they are to meet demand.

Axel Flaig, head of research and technology for Airbus SAS, told delegates aerospace manufacturers must explore new ways of designing and manufacturing aircraft and invest in emerging technologies to ramp up production and satisfy consumer demand.

Breakthrough technologies like ultra-high bypass ratio engines or hybrid-propulsion, electrically driven aircraft will improve performance by up to 25 per cent in the future and 'bionic design' will lead to great gains from the manufacturing efficiencies that 3D printing will bring.

Creating new composite wings, printing parts or the entire fuselage and exploring printing electrical networks

and circuits on cabin walls will reduce weight, speed production and mean fewer wires.

Flaig said aircraft will have to be produced in a more autonomous way and manufacturers will need to explore the use of fully 3D machinery, with the ability to feedback real-time process data to optimise production, to adjust components at the moment of assembly, be able to commit to the high-volume production of new designs and fulfil demand for ever more customisation of fleets.

"We have to mature designs early in production in a virtual product environment, so suppliers can optimise, test and check manufacture before detailed designs are finalised," said Flaig,

adding this would give manufacturers the ability to fully integrate design process into their digital factories of the future.

To grow business potential, companies need to find ways through the challenges of design and production to make new aircraft sustainable, efficient and operational as quickly as possible.

Whilst simultaneously improving existing aircraft and upgrading engine solutions, Flaig said that demand in itself provides an amazing opportunity for manufacturers to find game-changing design or breakthrough technology that will allow them to keep their competitive advantage.

“ We have to mature designs early in production in a virtual product environment, so suppliers can optimise, test and check manufacture before detailed designs are finalised. ”

Axel Flaig



New alloy could be the first of a new generation of titanium alloys offering improved performance

Delegates attending the TRAM conference were told of a new titanium alloy that offers improved tool life, reduced weight and better performance than competing materials. This new alloy could be the first in a family of new materials for a range of aerospace applications.

TIMET, which has been producing titanium for more than 60 years and supplies nearly one-fifth of the world's titanium demand has developed a new alloy TIMETAL 407.

Roger Thomas, applications development manager at TIMET UK, told the conference that TIMETAL 407 purports to have an increase in fracture toughness and a 70 per cent improvement in ductility over the more traditional Ti-6Al-4V. TIMETAL 407 has also been shown to offer equivalent mechanical properties to Ti-6Al-4V such as stiffness, corrosion resistance and thermal expansion. Therefore it could

be used as a substitute by companies prepared to consider taking advantage of the new material's improved mechanical properties and increased machinability.

Further studies have also shown that TIMETAL 407 can be used instead of Ti-3Al-2.5V and Ti-230 in applications needing equivalent or improved strength and ductility. TIMETAL 407 can also be used as a substitute for commercially pure (CP) titanium for fasteners and swaged parts thanks to its equivalent ductility, reduced weight and increased strength.

TIMETAL 407 has been put through its paces by the Machinability Group at the Advanced Manufacturing Research Centre, which carried out a series of benchmarking tests as part of ongoing work with TIMET.

Group technical lead, Dr Pete Crawforth, told the conference that during V15 machinability trials a cutting speed of 156 m/min had been achieved with



Roger Thomas, applications development manager at TIMET UK



Dr Pete Crawforth, AMRC Machinability Group technical lead

TIMETAL 407, compared to 70 m/min for Ti-6Al-4V. V15 cutting speeds correspond to the maximum achievable cutting speed for a predetermined insert wear limit following 15 minutes of machining during a semi-finishing turning operation.

TIMET's Roger Thomas told the conference: "We are at the start of opening up a new field of titanium alloys."

"This should be regarded not as one alloy, but the first of a number of alloys of different strengths and properties which we will continue to work with the AMRC to develop. We have the ability to tailor properties of titanium alloys to suit applications and are looking for ambitious engineers who will work with us to make your lives a lot easier."

TIMET says it wants to carry out more work with the AMRC on optimising the machining strategies used for TIMETAL 407 for different applications.



Diamond-coated cutting tools drive up productivity in machining of composites

Jiro Osawa, technical managing director, OSG Corporation

Developing new ways of machining composites is vital if companies are to meet increasing demand from the aerospace sector, according to Jiro Osawa, technical managing director of global cutting tool and machining specialists, OSG Corporation.

Osawa told delegates carbon fibre reinforced plastic (CFRP) technology was introduced for the F-2 fighter jet in the mid-90s. Since then, the use of composite structures in aerospace manufacturing has sky-rocketed. Now over 50 per cent of commercial jets such as the Boeing 787 and Airbus A350 are constructed using fibreglass and composite materials.

OSG conducted research into efficiently drilling holes in composite stacks for the wings of the F-2, securing it the opportunity to be the main cutting tool supplier for the CRFP wings. This experience informed expansion of its product line, developing tools tailored to machining CRFP.

Osawa said conventional cutting tools could leave uncut fibres and cause delamination and galling of the machined surface area; leading to the material's structural failures. Advanced tooling methods and cutting tools with a sharp leading-edge and high-wear resistance are needed to drill defect-free holes for aerospace applications.

Cutting tools and leading edges can be made from a variety of materials, but OSG found a tungsten carbide tool-bit



Mitsubishi F-2 multirole fighter

offered the best flexibility in design, while a mono crystal diamond (MCD) tool provided the best sharpness and a high degree of wear-resistance when machining CFRP.

Applying a diamond coating before grinding and polishing the tool edge has allowed OSG to create more precise leading edge shapes and an MCD boron-doped tool reduced oxidation and carbonisation, allowing the tools to retain a sharper edge for longer.

Osawa told delegates the sharper cutting edge allows higher-quality defect-free holes, with no micro-chipping to be produced and the extended tool life means manufacturers can increase productivity when machine drilling CRFP stacks for aerospace.



A mono crystal diamond (MCD) tool provided the best sharpness



Now is the time to recognise the value in measurement technology

Recognising how information technology will in future be connected with and provide feedback directly into manufacturing processes will increase efficiency and productivity in real-time, according to David Brown, general manager at Hexagon Manufacturing Intelligence.



David Brown, general manager at Hexagon Manufacturing Intelligence

Hexagon Manufacturing Intelligence attended the TRAM conference to demonstrate the value of investing in measurement technology and how practical application of measurement in assembly will create better outcomes for businesses.

Brown said innovation in metrology was about capturing data for analysis that companies could react to in real-time, alongside a working process, adding: "Capturing quality data as early as possible in the design or manufacturing process is always cheaper and more efficient than having to correct errors in production later down the line."

Advantages of integrated measurement technology included scanning for guided part placement, on-part data visualisation, aligning parts to run a full cycle programme, minimising the movement of parts of the shop floor and online inspection to allow errors to be corrected in-process; leading to greater real-time control over process workflows, improving efficiency and productivity.

Brown said metrology and IT are now so closely linked; the skill is not in how to measure, but how to connect various data sets to make informed decisions by making it accessible for the next generation.

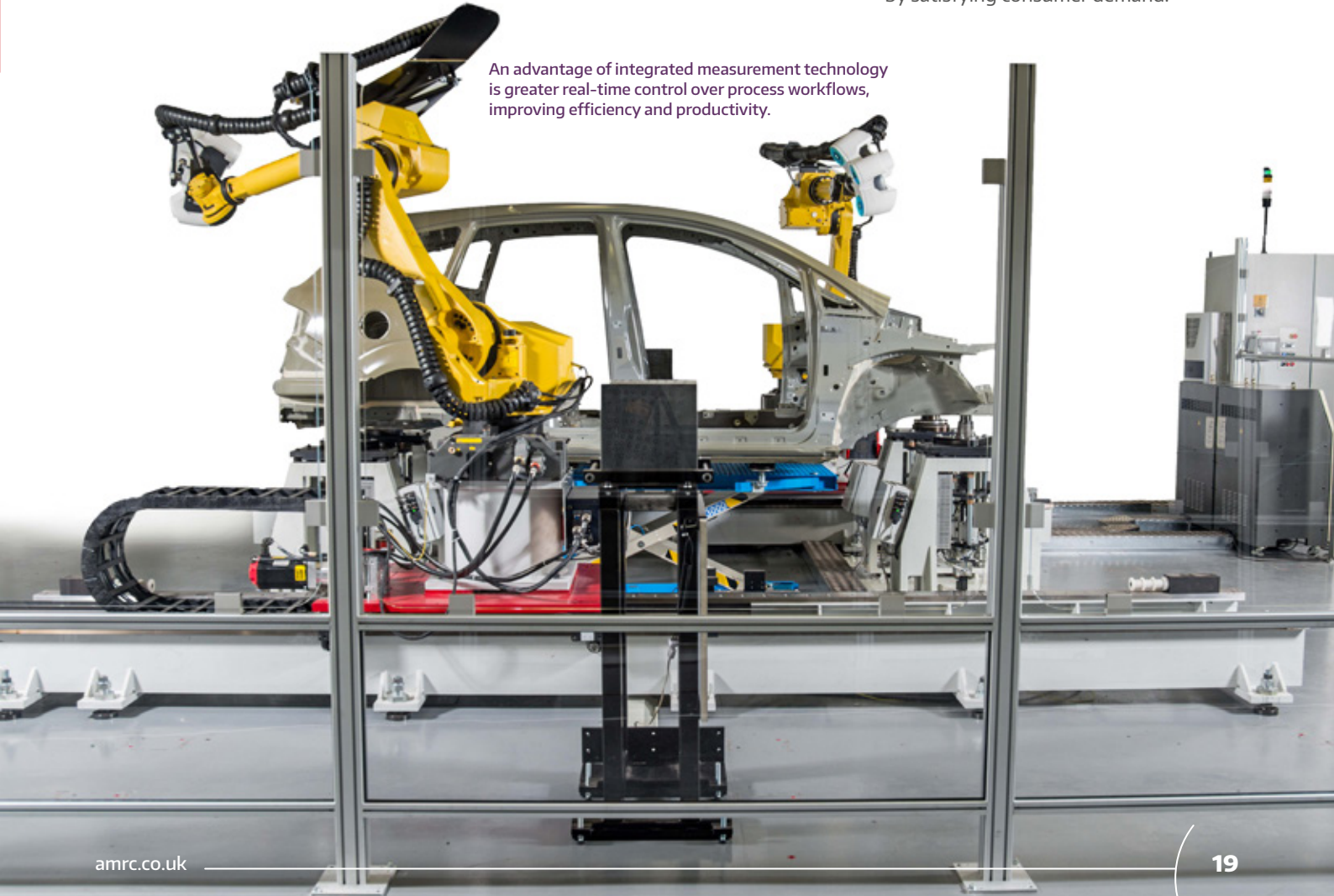
Manufacturers should increasingly use smart platforms to provide true real time control over their processes by sending notifications to mobile devices and making a single source of data available to everyone.

Investing in measurement technology works well with a new product, change in process or a model face lift, Brown told delegates.

They could create newer products within a shorter timeframe by correcting errors in design and manufacture 'in-process'.

Meanwhile, having data capture and automatic measurement in-process improved ramp-up times and times to volume, offering commercial advantages by satisfying consumer demand.

An advantage of integrated measurement technology is greater real-time control over process workflows, improving efficiency and productivity.





Meeting the challenge of making 'blisks' for the commercial market

Rising demand for 'blisks' – bladed discs which combine the compressor disc and blades in a single component – are posing new challenges for manufacturers.

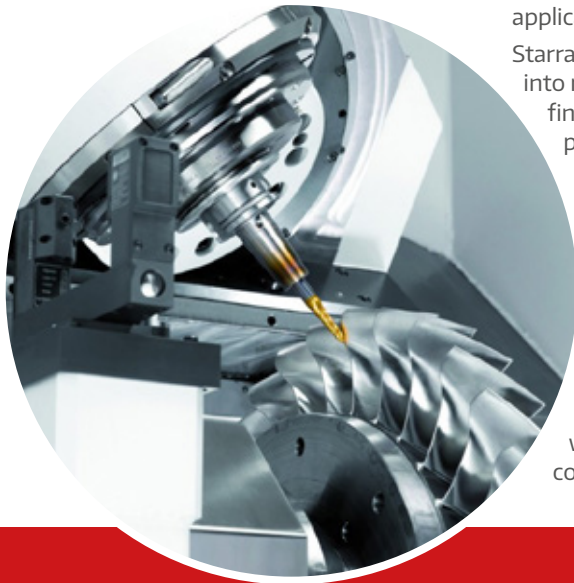
Blisks are increasingly being specified for mainstream commercial propulsion units.

However, nickel blisks are very difficult to machine and making them in a more

efficient and competitive way means developing new strategies, says Dr Bernhard Bringmann, managing director of Starrag, the leading supplier of machine tools, software, fixtures and other systems for aerospace and energy applications.

Starrag has been carrying out research into new roughing and chatter-free finishing strategies for improving productivity when machining blisks, working with Walter Tools as part of the process, Dr Bringmann told the TRAM conference.

Using ceramic tools instead of solid carbide to slot out paths between blades increased productivity, but tool life could be as low as four minutes, which made it difficult to be cost competitive.



Dr Bernhard Bringmann, managing director of Starrag

Switching to plunge roughing, with long tools, increased tool life for both conventional and brazed ceramic tools, which have a ceramic tip brazed on to a solid carbide shaft and allowed much higher cutting speeds as chatter was avoided by directing the cutting forces into the spindle and the machine table.

Trochoidal milling – using a circular movement to machine slots wider than the tool – with a solid carbide tool was twice as fast as conventional processes and improved tool life in addition to increasing metal removal rates and reducing cycle times.

It was also an ideal process for difficult machining situations involving materials like titanium and Inconel, which are both common blisk materials and could be used for creating blisks that were close to their final shape before pre-finishing and finishing.

Act now to ensure sustainability of manufacturing processes by investing in advanced cutting fluids

With new regulations on the production and use of cutting fluids additives due to come into force in 2018, the time has come to switch to newly developed advanced cutting fluids, Edward Jones chief operating officer and technical director for Hangsterfer's Laboratories told delegates.

Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulations, governing the production and use of chemical substances will make some traditional cutting fluids obsolete and users must verify the sustainability of the cutting fluids they are buying, to prevent disruption to manufacturing processes.

"Most cutting fluids in use today were

developed in the 1970's and weren't developed for the steels and alloys used today," said Jones.

"The development of cutting fluids today takes into account modern tribology needs, incorporating all the mechanisms of tool-wear prevention to endure the complexity of modern manufacturing."

Modern synthetic materials can withstand higher temperatures and the use of vegetable-based oil additives means they lubricate surfaces more effectively.

Jones said advanced cutting fluids have an extended life, reducing consumption, keeping machines cleaner, creating less waste and cutting costs. Users also benefit from a 70 per cent reduction of

the fluids' carbon foot print and a 95 per cent increasing in chip and swarf value.

Switching to advanced cutting fluids complying with current and future regulations should also reduce environmental damage.

Jones said newly developed fluids need to be biostable, lowering the use of harmful substances, and biohard - offering lower abrasive wear with lower micro filtration levels; resulting in fewer abrasive particles that can damage the process or attacking tool casings.

"Traditionally the manufacturing process was engineered around the limitations of the cutting fluids, not the tools or machinery, we can now make great gains by engineering the cutting fluid as part of the process," he added.



Edward Jones chief operating officer and technical director for Hangsterfer's Laboratories



Tool holding advances help to raise material removal rates and cut costs

Steve Eckersall, group engineering manager for Nikken Kosakusho Europe

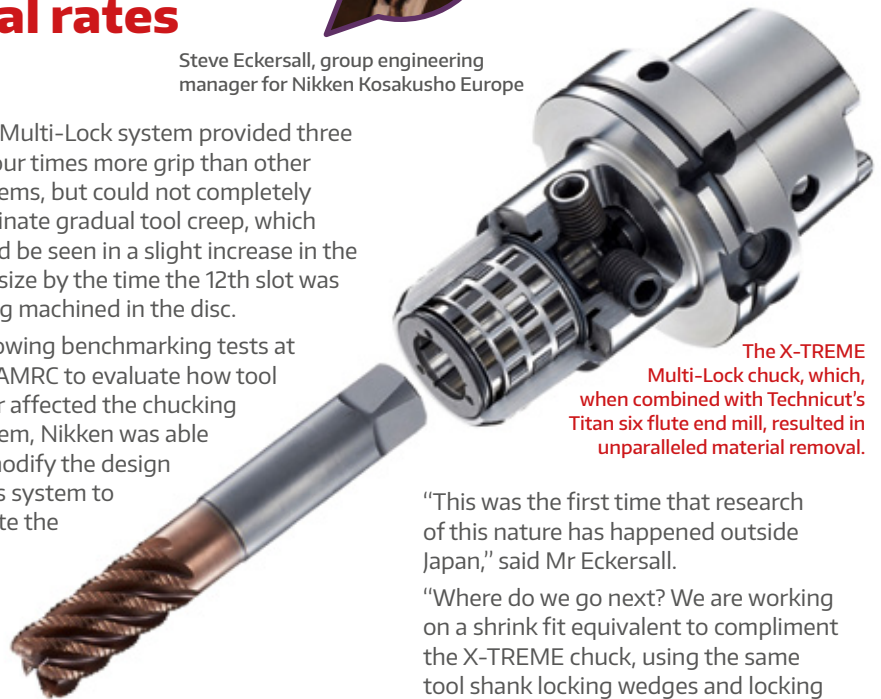
New tool holding solutions, designed to help advanced manufacturers to significantly increase productivity, without compromising tool wear rates, are set to emerge from collaboration between Nikken Kosakusho Europe, cutting tool manufacturer Technicut and the AMRC.

Delegates to the TRAM conference heard how the three organisations had joined forces to find ways of increasing the speed of machining aero engine discs, while reducing the number of cutting tools and assemblies needed to carry out the process.

Steve Eckersall, group engineering manager for Nikken Kosakusho Europe, told the conference Nikken had been approached to see if its Multi-Lock patented tool holding system could solve tool holding problems which appeared when attempting high material removal rates.

The Multi-Lock system provided three to four times more grip than other systems, but could not completely eliminate gradual tool creep, which could be seen in a slight increase in the slot size by the time the 12th slot was being machined in the disc.

Following benchmarking tests at the AMRC to evaluate how tool wear affected the chucking system, Nikken was able to modify the design of its system to create the



The X-TREME Multi-Lock chuck, which, when combined with Technicut's Titan six flute end mill, resulted in unparalleled material removal.

X-TREME Multi-Lock chuck, which, when combined with Technicut's Titan six flute end mill, resulted in unparalleled material removal.

"This was the first time that research of this nature has happened outside Japan," said Mr Eckersall.

"Where do we go next? We are working on a shrink fit equivalent to compliment the X-TREME chuck, using the same tool shank locking wedges and locking system.

"The Shrink Fit X-TREME should be a more effective chucking solution for everyday use."



Increases in productivity and potential applications broaden additive manufacturing's scope

Dr Greg Hyatt, senior vice president and chief technology officer for DMG MORI ASI

Dramatic increases in productivity and extensions to the range of applications for additive manufacturing (AM) are helping to transform the technology into a productive tool.

Dr Greg Hyatt, senior vice president and chief technology officer for DMG MORI ASI, told the TRAM conference that additive manufacturing had to become significantly more productive if the technology was to be more widely used.

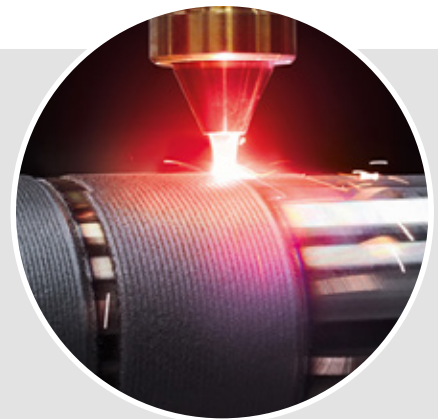
However, AM had opened the way to creating multi-metallic components, with variable properties that could be tailored to meet requirements in specific areas and integrating AM and subtractive manufacturing (SM) processes would allow components that need machining mid-build to be made to

the tolerances and accuracies associated with milling and turning.

Combining AM and SM would also allow assemblies that currently have to be made from many parts to be replaced by a single component, said Dr Hyatt.

Ultrasonic assisted machining could also be integrated with conventional SM and new AM technologies.

"Ultrasonic machining is historically associated with brittle materials, but is extremely beneficial for finish milling hard metals, associated with the aerospace industry," said Dr Hyatt, who also held out the possibility of qualifying parts while still on a machining centre by building samples onto the component which could then be machined off and tested.



Lasertec 65: DMG MORI integrates for the first time the additive manufacturing into a high-tech 5-axis milling machine.

Dr Hyatt cited rocket motor nozzles as an example of one type of component that would benefit from being made on hybrid equipment.

The nozzles are typically made from layers of copper and nickel alloys with a cooling labyrinth between them. A hybrid machine could deposit both layers, pausing to mill the cooling channels in between, before resuming the deposition process.



Managing distortion through tool path optimisation offers major savings for aerospace

Ravi Bilkhu, technical lead, AMRC with Boeing's Process Modelling and Residual Stress Measurement Group

Improved understanding of how components can distort when residual stresses are redistributed during machining could help aerospace companies save hundreds of millions of pounds.

Ravi Bilkhu, from the AMRC with Boeing's process modelling and residual stress groups, outlined initiatives to develop tailored machining strategies which avoid distortion leading to components having to be reworked or scrapped and to assembly problems.

Residual stresses are caused by many factors including large thermal gradients, plastic deformation and metallurgical changes in components during manufacture and are independent of any external loading. The distortions produced when residual stresses are redistributed can be hidden during on machine probing and may only become apparent with the component is released from its fixture.

In order to meet industrial demands of high productivity and reduced lead times the components need to be manufactured faster and with very high precision. Regardless of the advantages of high speed machining, part distortion has a major impact on lead times and costs.

"From 2002 to 2007, major aerospace companies found distortions were costing the industry hundreds of millions of pounds," Bilkhu told TRAM conference delegates.

Components made from aluminium, new nickel and titanium alloys and thin-walled components were all susceptible to distortion which could be avoided by developing an optimum machining strategy.

The first step was to understand the effect of the forging or casting process and any subsequent heat treatment on residual stresses by creating a model that could be validated and compared with stress data from the component.

Next, the fixture and machining process had to be investigated and the resulting

data incorporated into the model which is then calibrated to ensure it produces the same results as experimental tests.

Residual stress measurement techniques the AMRC utilised to validate models included:

Contour method – an acceptable, cost effective, but destructive technique for measuring stresses.

X-ray diffraction (XRD) – a useful non-destructive method for capturing machining induced stresses, near surface and surface stresses, which could be used to optimise machining strategies and could also be used to understand a component's fatigue life.

Ultrasonic stress measurement – a portable, robust, non-destructive method for measuring bulk and surface stresses.

Digital image correlation – another non-destructive method which can be used for real-time, on-machine inspection that can also feed data back to the machine to modify its operation.

Neutron diffraction measurements – collaborating with both local and international neutron facilities to measure residual stresses non-destructively in the bulk of the component.

Once a model has been created for the current manufacturing method, the process can be optimised by considering the effect of different fixturing systems and metal removal strategies.

"We look at different strategies for metal removal and their impact on component conformance, while trying to keep productivity high," Bilkhu told delegates.

"We create a more flexible strategy for optimising machine distortion, apply it to an experimental tool to validate it, create protocols for production and come up with a robust tool path."





Clean sheet approach helps Walter meet new material challenges

Jim Dale, Walter's aerospace component manager

Going back to the drawing board is helping cutting tool manufacturer Walter to meet the challenges posed by the introduction of new aerospace materials and demands for increased productivity.

Walter's aerospace component manager, Jim Dale, told the TRAM conference that new cutting tool technology had to be developed to achieve high removal rates and short machining times with new alloys.

The alloys offered lower specific weights and improved stiffness and fatigue properties, which also led to enormous drops in tool life and reduced productivity.

Walter had asked itself what new, innovative technologies it could introduce to solve these problems.

Developments had included a new generation of indexable inserts with four cutting edges that had the right geometry for titanium and an innovative tool that was capable of dynamic milling as well as carrying out existing strategies.

It had developed a completely new range of indexable cutting tools for roughing aluminium and introduced a new technology substrate onto which thin film coatings could be deposited which provided higher temperature resistance and retained the cutting edge for different tasks.

In addition to studying conventional coatings and how to produce really smooth coatings, the company had launched a project to develop new coatings and coating processes.

Walter indexable insert



The company had also risen to the challenge of recovering the downturn in tool life resulting from the introduction of lithium aluminium and it had worked with the AMRC to develop a generic part which could be used to generate cutting tool data and benchmark tool performance and worked with partners to develop tooling strategies that would result in a step change in productivity.

Don't replace existing inefficiencies with new ones, improve what you already have

Peter Hammond, the technical director for Metrology Software Products

Demand for new aircraft means aerospace manufacturers will need to grow by 20 per cent a year, an extraordinary amount for any company, but how are they going to do it? asked Peter Hammond, the technical director for Metrology Software Products (MSP).

MSP helps companies to increase productivity by giving them ideas and strategies for changing tools, methods of manufacture and scaling up processes.

It says using advanced techniques can directly affect the number of machine tools and time needed to machine parts and manufacturers can make the necessary changes by using the equipment they already own in different ways, instead of investing in more machines.

The key is to resolve potential issues at the design stage, removing as many errors as possible in the part set-up and machinery before manufacturing begins, Hammond explained. This avoids bottle necks in production and inspection-stage failures by rectifying

errors prior to cycle starts.

MSP involves NC programmers in part production to help work out cutter paths, time on each machine tool and simulate anything that is possible before a part is made. Checking machining capability and conducting test runs in the warm up cycle produces consistent part quality and over time, improves results.

The company helped reduce the cycle time for the Eurofighter foreplane from a seven day process, with eight operations, 22 hours rework on every part, high scrap and concessions to just five hours per workpiece with no rework, scrap or concessions.

"Using what companies already have can increase part quality, maximise use of available machining resources and reduce costs, which are all critical if aircraft production targets to be met," said Hammond, adding that MSP had enabled some companies to increase capacity ten-fold by making more effective use of existing machine tools, people and factory space.

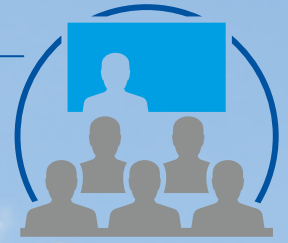


"There is always room for expansion of your company's infrastructure, but if you change the way you work with what you already own, significant improvements to output can be made with drastically lower costs," Hammond added.



Image: Peter Gronemann

MSP helped reduce the cycle time for the Eurofighter foreplane from a seven day process, with eight operations, 22 hours rework on every part, high scrap and concessions to just five hours per workpiece with no rework, scrap or concessions.



Don't delay - now is the time to capitalise on opportunities offered by the

Internet of Things

Companies from the UK's advanced manufacturing sector have been urged to grasp the nettle and start creating products that make use of the 'Internet of Things.'

The call came from a panel of experts answering questions from delegates attending an Internet of Things seminar at AMRC's Knowledge Transfer Centre.

The term "Internet of Things" (IoT) was coined by British entrepreneur Kevin Ashton in 1999 to describe a network of physical objects or "things," with embedded electronics, software, sensors, and the ability to collect and exchange information over a network.

In manufacturing, the technology is the foundation for what has been dubbed the fourth industrial revolution or 'Industry 4.0.'



Experts speaking at the seminar included:

Richard Allan from PTC, which provides technology solutions that transform how products are created and serviced; **Jon Hill and Jan Hemper from InVMA**, which specialises in technology to connect all types of devices, equipment and people, no matter where they are.

Joost Bossina from Thingworx, developers of the first IoT software platform designed to build and run the applications of smart, connected products and **Ben Morgan, from the AMRC's Integrated Manufacturing Group**.

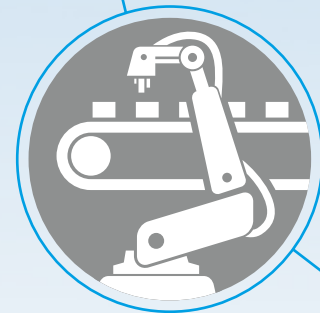
They told a mixture of manufacturers, technology and software suppliers the biggest barrier to reaping the benefits of the new technology was inaction;

urging them to "just do something and don't spend too much time thinking about it."

Delegates were encouraged to start small and build from there. "Don't boil the ocean. It doesn't have to be a big solution," said the experts.

Asked how they would convince clients to embrace the new technology, the panel suggested finding the client's biggest problem and using the IoT to solve it and reminding them how Kodak collapsed after creating but failing to develop the world's first digital camera, because the company preferred to keep producing photographic film.

Ben Morgan told the seminar: "My experience is that it is a lot about changing people's mind sets and companies' cultures towards disruptive technologies.



"We have done that by showing them what can be done to fire their imagination."

Delegates who were concerned about security were told that it was important to have systems and processes in place and not to expect software protection to be the "silver bullet."

Companies had to have a holistic approach and not just consider the security of individual items.



Making smart connections will unlock billion dollar business opportunities

Richard Allan, PTC senior regional director for the UK and Ireland



Smart connected systems are set to bring about a big change in the way we react to the world and open the way to multi-billion dollar opportunities in incremental business, PTC's Richard Allan told the Internet of Things seminar.

PTC develops design software and technology including product lifecycle management, and service management solutions.

Richard Allan outlined how its connected systems were already being used in agriculture.

At first, developments were focused on providing information about how an individual piece of farm equipment like a tractor was performing and collecting data to assess the product's life cycle.

Now, combine harvesters were collecting information about the yield in different parts of a field, allowing farmers to fertilise and seed in the right areas and were being connected

to weather systems and sensors in the field.

Smart, connected factories were one of the most interesting areas for potential development, particularly in sectors like aerospace, helping companies to ensure they avoided massive penalties for failing to meet delivery terms, or by analysing data to help take costs out of warranty claims.

The Internet of Things would have a strategic effect, enabling companies to develop new revenue streams, elevate customer relationships, improve customer loyalty and differentiate their offering from other companies.

It could also have a disruptive effect, enabling companies to develop entirely new business models including a platform of applications enabling companies to create, connect, analyse, operate and service products.



IoT offers opportunities to close the UK's productivity gap and meet new supply chain challenges

Ben Morgan, head of the AMRC Integrated Manufacturing Group

UK manufacturers are facing a series of challenges from customers and competitors which could be met and overcome if they are willing to embrace the Internet of Things and capitalise on its capabilities as a facilitator for automation.

Customers, in aerospace, in particular are demanding tighter tolerances, improved repeatability and better traceability, said Ben Morgan, from the AMRC's Integrated Manufacturing Group.

At the same time, manufacturers need to battle against unfavourable

comparisons between Britain and other countries when it comes to productivity and to overcome an impending loss of skills and experience as an aging workforce reaches retirement.

Morgan warned that low cost manufacturing economies were themselves investing in automation and technology.

Meanwhile, traditional methods of aerospace manufacturing, where some components were put together and drilled, were falling out of favour because they resulted in variations in hole positioning meaning it was difficult to fit replacement parts.

"We see the Internet of Things as a facilitator for automation – something to make the lives of manufacturers easier," said Morgan.

IoT technologies could help companies meet the demand for traceability without the need for a folder full of plans and information to follow components around the factory floor.

The same technologies could also help to capture the knowledge held by the aging workforce and embed it within products and systems.

And, they could be installed in legacy factories and on high value, legacy equipment to warn of and avert impending failures which could cost companies millions if they stopped working without warning.

Data produced by the IoT could be used to reduce response times in the supply chain, reassure customers that production schedules were being met and to add value to products as a result.

The technologies would all be tried and tested in the AMRC's new Factory 2050, which would also be investigating ways of meeting demand for even higher customisation of products and more rapid ramp up and ramp down production.





Manufacturers urged to boost value by developing subscription-based services



Jon Hill – business development director of InVMA

New opportunities to use the Internet of Things to turn businesses built around product sales into subscription-based service industries could significantly increase their value, according to Jon Hill, of InVMA.

“Instead of issuing a single invoice, you are providing an ongoing, subscription-based service,” Hill told the IoT seminar.

“If you can turn one dollar of capital purchase into one dollar of ongoing revenue, your share price will go up by ten times that because it shows you have a connection with the customer that is more robust and lower risk.”

Hill, whose company specialises in technology to connect all types of devices, equipment and people, cited Michelin as one company that had moved from selling a product to a service.

“Michelin started making tyres and began producing them with sensors,” said Hill.

“It then realised that if it provided hauliers with information showing how they could save money by having their tyres at the correct pressure it could use that information to start selling tyres as a service, by the mile.”

Another InVMA client had moved from manufacturing and selling air compressors to using data from the compressors to enable it to develop a preventative maintenance service. Now, instead of selling replacement compressors, the company was building compressor plants on customers’ premises and selling them air as a service.

The switch had extended the life of the compressors, which customers had failed to maintain properly when they owned them, and the compressor company had achieved energy cost savings and avoided plant shut downs during energy management periods.

“Air is the second biggest source of energy use,” said Jon Hill.

“By making compressed air at night and storing it for use during the day, they don’t have to shut the plant down during demand management; they just shut down the compressor.”

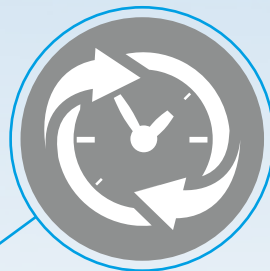
Aero engine manufacturers had moved from offering scheduled to preventative maintenance and aircraft fleet optimisation services.

“They have moved from product to providing information services,” said Hill, who believes the auto industry will move from selling vehicles to selling cars as a service.

Companies needed to think about the products and services they offered their customers and how they are going to change that as they capitalise on the opportunities offered by the Internet of Things, but they also needed to consider their people.

“Don’t forget about people. People find it hard to change,” he told the seminar.

“Some projects fail because companies don’t realise they are fundamentally changing the business model and that involves fundamentally changing the people.”





Schools scheme shows Internet of Things' scope for raising customer satisfaction



Jan Hemper – technical director of InVMA

Initiatives that make use of the Internet of Things must address specific business needs and produce tangible benefits that justify the investment, InVMA director Jan Hemper told the IoT seminar.

“Most of the projects we have executed have started with proving the new features are going to be useful and people will want to buy them,” said Hemper.

IoT technology could bring a number of benefits, including improving customer satisfaction and preventing unplanned downtime by providing pro-active servicing and replenishing consumables automatically when they run low.

The technology could be used to ensure that when equipment does break down, people with the right skills and the right parts to repair the equipment arrive first time.

It could also be used to collect data that prevents warranty claims when equipment has been misused, highlight the need for operator training, evaluate how frequently features are used and feedback information that could be used to improve the products.

Jan Hemper cited the maintenance and operation of combined heat and power (CHP) schemes at schools by integrated support services group Carillion as one example of the successes that could be achieved with IoT technology.

Carillion had been involved in a programme to build a number of low carbon schools and operate them for 25 years.

The schools had CHP plants running on vegetable oil which provided heat and power for the school and an income from selling excess energy.

However, there were no means of flagging up failures when they happened and, with no CHP expertise on site, that could lead to fines for failing to meet contractual obligations and lost revenue.

The result was a high number of call outs for maintenance engineers, who were notching up significant mileage. A lack of information meant the engineers didn't know which parts were needed, resulting in further trips, and, during the summer, there were complaints from people living near the schools about the noise the CHP plants were making.

Although the plants at different schools might be using different control systems and protocols, InVMA was able to develop a low cost, high value system which connected to the plants and created digital twins, which made it possible to alert engineers and allow them to diagnose the problem off site.

The system also scheduled the operation of the CHP plants in the summer, reducing the noise and the number of complaints.

“When there is a failure an engineer is alerted instantly and can attend before the client is aware of the problem,” said Hemper.

“Engineers can plan their days much better, noise is reduced dramatically, which reduced the number of

complaints and we were able to include local weather data, to allow asset performance and failure patterns to be better understood.”

The number of call outs was significantly reduced and the success of the system prompted demand for the system to be expanded so that it could be used to reduce costs by improving the scheduling of fuel deliveries and connected to building management systems allowing energy performance to be improved by benchmarking schools against each other.

Jan Hemper urged anyone trying to deliver an Internet of Things solution to engage with the end user early in the process and to deliver “the minimum viable solution, rather than everything at once.” They also needed to reduce the cost of data transmission by using a “push by exception” strategy which meant information was only sent when it needed to be sent and wasn't sent for the sake of it.





Techfellows15

The AMRC Partner Conference



AMRC plans further expansion

on the back of rising turnover and a full order book

The AMRC with Boeing and the Nuclear AMRC are heading towards a turnover of between £45 million and £50 million, executive dean, Professor Keith Ridgway told the AMRC's Tech Fellows conference.

"We are doing well; our turnover is growing, we have got a full order book for the next 18 months and we are in line to make a good margin," said Prof Ridgway, speaking to the annual gathering for its commercial partners.

A total of 560 people are now employed by the two centres, which are both members of the High Value Manufacturing Catapult, an alliance of seven leading manufacturing research centres backed by the UK's innovation agency, Innovate UK.

Major investment in the AMRC was continuing, said Prof Ridgway.

A new, 1000kg titanium melting facility was being installed at its AMRC

Castings operation and more state of the art equipment had been acquired by the AMRC's new grinding centre of excellence.

At the same time, the multimillion pound development of Factory 2050, the AMRC's revolutionary, new, glass-walled "reconfigurable factory" was already encouraging existing and potential AMRC partners to locate close to its Sheffield Business Park site.

But, the AMRC's expansion wasn't stopping there. The University had an option on more land on Sheffield Business Park and there were ambitious plans to join that site to the AMRC's Advanced Manufacturing Park base as part of plans to develop an Advanced Manufacturing Innovation District (AMID).

The devolution deal for the Sheffield City Region, signed by Chancellor of the Exchequer, George Osborne, in

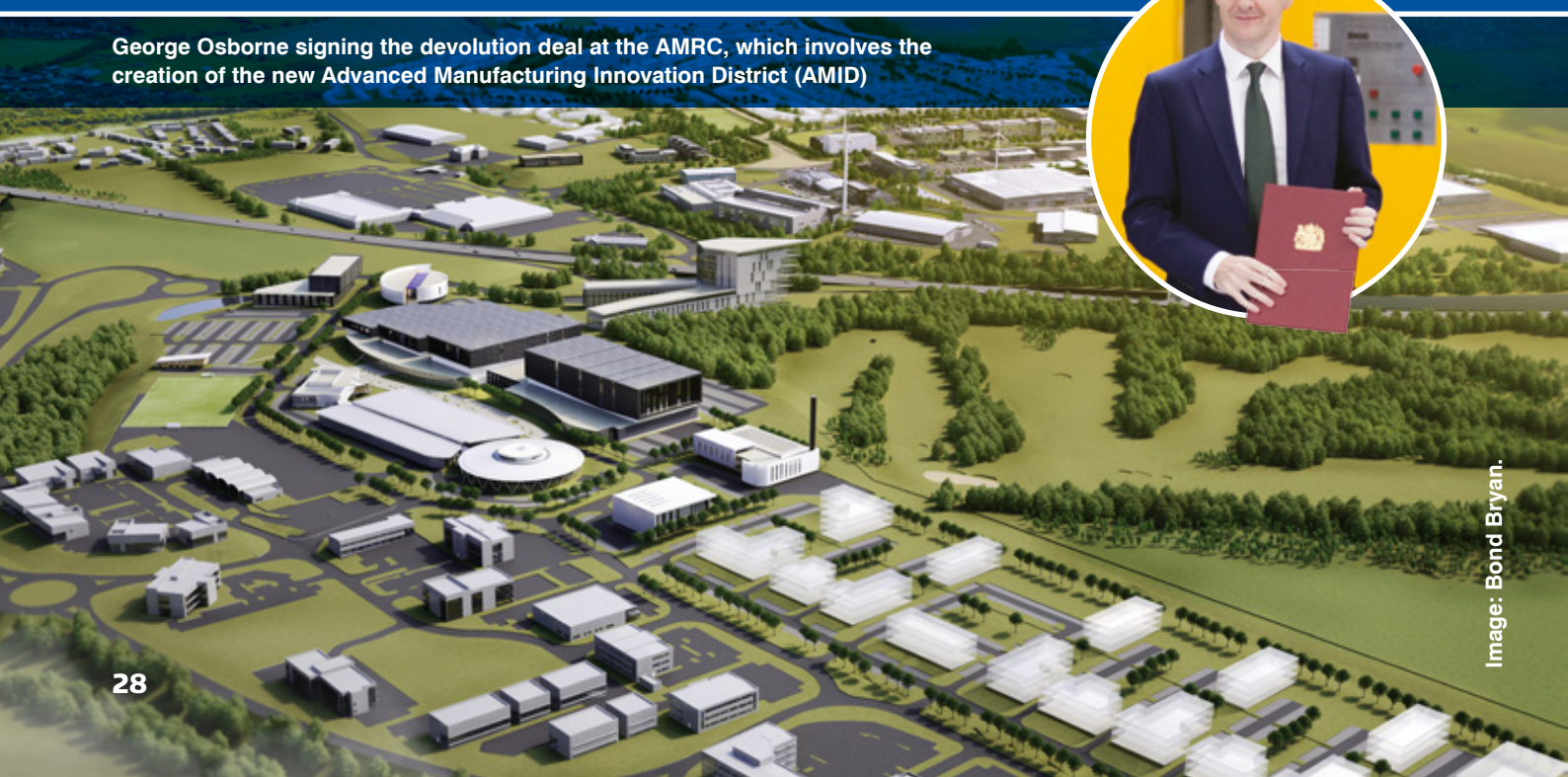
the AMRC's Rolls-Royce Factory of the Future would fuel the AMID's development.

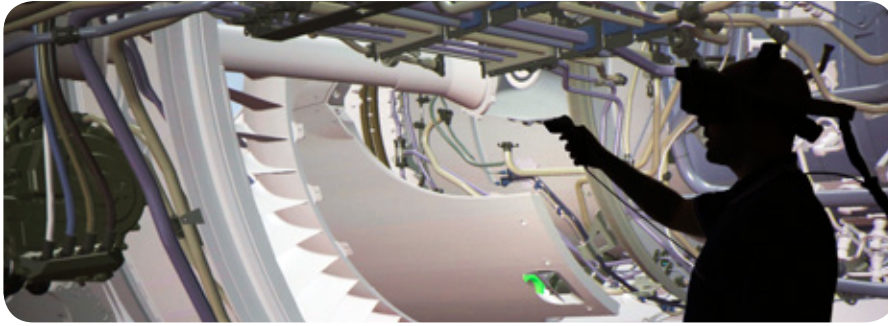
Further developments within the region could include the creation of a centre focused on developing technologies for the rapid manufacture of castings and the AMRC was planning to expand its award winning apprentice training programme to include nearby Barnsley.

Prof Ridgway told the Tech Fellows conference that the AMRC was also pursuing opportunities elsewhere in the UK and abroad.

Proposals had been submitted to establish a North West AMRC in the UK, the organisation was establishing a Korean AMRC and exploring possibilities in the Middle East.

George Osborne signing the devolution deal at the AMRC, which involves the creation of the new Advanced Manufacturing Innovation District (AMID)





Growth continues at AMRC centres following further investment in people and equipment

Major expansion at the AMRC's Integrated Manufacturing Group has seen staffing levels grow by 50 per cent, paralleled by significant investment in additional capabilities ahead of the group's move to its new Factory 2050 headquarters.

The group explores advanced technologies and develops new ways of automatically assembling complex products to help partners in the aerospace and other high-value industries improve their global competitiveness.

New capabilities include additional robotics, metrology, digital technology, informatics and augmented reality, the Tech Fellows conference was told.

Research topics include developing technologies for reconfigurable factories and exploring the potential of augmented reality using head mounted displays, hand held mobile devices and projection technology, and technologies for supporting digitally assisted assembly.

The group is also developing effective, low cost techniques that will enable robots to locate the correct place on a part to start machining operations and working on improving the accuracy of robots so that they can be used for tasks with increased accuracy requirements, such as drilling, fastening, assembly and machining.

The conference heard how work carried out by the AMRC's Design and Prototyping Group on design for additive manufacturing was helping to reduce build times by up to 40 per cent and creating ways of integrating electronics and conventional wiring into components produced by 3D printing.

The group is responding to demands for increased sustainability by developing ways of designing products that maximise the ability to recycle them when they reach the end of their useful life.

It is also developing new management techniques for design processes, including more forum-based, open management structures that move away from conventional linear project management, which fail to reflect what designers do in reality.

Tech Fellows delegates heard how the AMRC's Machining Group was continuing to develop ways of predicting and avoiding chatter and vibration in the machining process.

Projects include developing a standard system for automatically collecting data on the dynamics of milling spindles, ways of predicting surface roughness and greater expertise in micromilling.

Meanwhile, manufacturing informatics and machine tool metrology specialists have been developing a software and hardware framework to support the deployment of monitoring systems within manufacturing environments, with the aim of monitoring the performance efficiency and machining process conditions of CNC machine tools under live production conditions

Delegates also heard how the AMRC was trying to fill a gap in grinding process development capabilities among the UK's research centres through further investment in equipment, in response to increased requirements for grinding and the introduction of new materials.



New vistas open up for AMRC Composite Centre

Collaboration between the AMRC's Composite Centre and researchers in Korea is rapidly increasing and has sparked moves to open an AMRC office in Korea, partners attending the organisation's annual Tech Fellows Conference heard.

The Conference gives partners, who include Boeing, Rolls-Royce, BAE Systems and Airbus an insight into the research and development work being carried out across the AMRC.

Attendees heard opportunities for further composite research could increase.

Meanwhile, work being carried out at the Composite Centre which aims to improve the reliability and quality of automatic deposition of composites could help the composites sector respond to rising demand which would remain unsatisfied if manufacturers had to continue relying solely on manual labour.

Future projects are likely to target ways of achieving high deposition weights with low wastage and zero defects and automatically identifying defects.

Inspection currently has to be carried out manually and can take longer than it takes to make a component, conference delegates were told.

Although few solutions to the inspection problem have been developed within the composites sector, AMRC researchers believe lessons learnt by other sectors that suffer similar problems – including the medical and food sectors – might be applicable to composites.

The Composite Centre is also examining a series of technologies for in-process inspection of automatic fabric placement. Technologies include 3D line-scanning cameras, lasers and metrology scanning equipment.



MICROMACHINING

Companies face a steep learning curve as demand for micro machining mounts



Arthur Turner, managing director, Rainford Precision



Demand for micro machining – producing components to tolerances of one or two micron – is set to mount over the next two to three decades, as capabilities increase, underpinned by an emphasis on sound engineering principles.

That was the message from Arthur Turner of micro machining centre and cutting tool specialist Rainford Precision, speaking at a micro machining seminar at the AMRC's Knowledge Transfer Centre.

Turner told delegates that current knowledge and capabilities were at the tip of the iceberg and there was a large amount still to be learnt as exponents explored different environments and tackled the different problems they raised.

"Micro machining is about putting good engineering practice into operation," said Turner.

"You need to think about the whole process. If you only apply a small proportion of what we are talking about today, you won't succeed. When you are working to micron tolerances, there are no short cuts."

Four main factors influenced capabilities to work to high precision – there were human factors, environmental factors, process factors and the machine itself; designers had to ensure their systems and methods would achieve micron tolerances.

"CAD/CAM systems have to be set so that you can machine to one micron tolerances," said Turner.

The mesh size set for the CAD/CAM system had to be correct and the machining strategy had to be right.

Designers also needed to be aware that the data they produced was not always good enough to achieve the tolerances required – something Rainford had demonstrated by comparing components made by manually programming a machine with those produced using CAD/CAM data.

Fortunately, CAD/CAM software developers had been developing new

techniques that avoided the risk of the small diameter cutters used in micro machining breaking.

Dust and dirt, temperature – including the effects of air conditioning and sunlight - workshop foundations and vibration transmitted from other equipment can all compromise capabilities to reach micron tolerances, said Turner.

A number of companies involved in micro machining had installed special gauze tubing to spread cold air emerging from air conditioning vents evenly and avoid cold spots developing within a machine which affect the ability to work to tight tolerances.

Even opening factory delivery doors could have an impact, Turner told the micro machining seminar.

A range of factors had to be taken into consideration when developing the manufacturing process – not least whether a company's measuring technology was sufficiently accurate to work to the tolerances required.

That meant using coordinate measuring machines (CMM) that were accurate to 10 per cent of the tolerance and might also mean installing the technology in a clean room, with operators wearing special clean room suits and positive air pressure to prevent dust and dirt entering.

A company's CMM could be the limiting factor, Turner warned, adding: "There are issues with machining centres being a lot more accurate than the CMM and we have come across a number of instances where it is the CMM that is wrong and not the machine or the technician."



Rainford Precision's 3 Flute Toglon drills for Hard Steel eliminates EDM drilling.



Attention to detail is a must when seeking to reach micron tolerances

Companies wanting to offer micro machining capabilities have to ensure the machines they are using are fit for purpose.

Polymer concrete or granite beds are resistant to growth, but companies using machines with traditional cast iron beds would face a tough job working to tolerances of five microns, Arthur Turner, from Rainford Precision warned delegates to the micro machining seminar at the AMRC's Knowledge Transfer Centre.

Companies also had to consider the materials used for the cutting tools, the tolerances on radius and diameter they were made to, coolant, type of chuck, the concentricity of the machining centre's spindle and workpiece clamping. "Tolerances on tool radius and diameter will impact on the accuracy and finish you can achieve," said Turner.

"Very high accuracy cutting tools will come with a certificate of conformity, but if you have to work to a micron accuracy, you may need to compare tools before you start to see if differences are going to have an impact on how you are going to machine the component."

Spindle concentricity had to be checked regularly and lack of concentricity could have a significant effect on tool life.

Zero Fit Chucks were the "get out of jail free card" if the spindle wasn't concentric, but required lower revolution speeds.

Heat shrink systems were well known for their accuracy and ultra-precision collets give good concentricity, while EX/ESX collet chucks were only suitable for general machining.

Many different cooling systems were available and it was essential to choose the right system for the material and size of the workpiece.

Cold air cooling might be necessary when machining polymers, to ensure the polymer remained brittle and produced chips, instead of becoming elastic.

In other circumstances the machine, the spindle and the coolant had to be warmed and kept at the same temperature to achieve tight tolerances.

A wide range of options were available when it came to workpiece clamping.

"There are micro vices and clamps, resin wax, ice and vacuum chucks, double sided tape," Turner told the seminar.

"You could use Loctite and get rid of the glue with warm water or hold a very, very small component on the base material while you machine everything around it and then cut it off. Literally anything goes."

Companies also had to consider what to machine, and when, said Turner, citing the case of one client who was asked to manufacture a radio wave filter for a



Micro drills ranging from 0.01mm up to a diameter of 2.0mm

satellite, which involved drilling 6,000 holes 0.1mm in diameter in a piece of copper, where the distance between the holes was typically just 0.01mm.

"The problem isn't drilling the holes, but the order in which you drill them," said Turner.

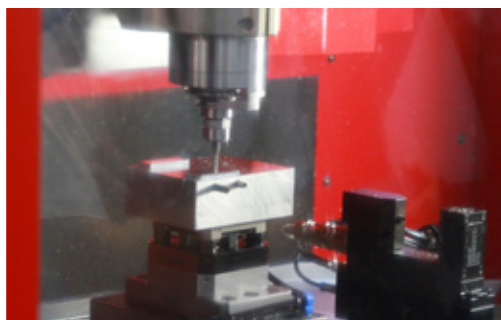
If the holes were drilled one after another in a line, stresses built up and the copper bent, so the array of holes had to be created by drilling the next hole in a different part of the copper sheet.

All the elements need to be addressed to ensure a successful result, it is critical not to omit any points as taking short cuts will cost either in time, money or component inaccuracy.

For more information visit:
goo.gl/qawfDD

drilling 6,000 holes, 0.1mm in diameter where the distance between the holes was typically just 0.01mm

Arthur Turner



AMRC Training Centre Courses

All courses held at the AMRC Training Centre, Rotherham, S60 5BL



16 March Fundamentals of metallurgy

This course provides an introduction to the principle alloy categories and their applications. It explains the properties of metals, how they are tested, how metal products are made and where they are used.

4-7 April Advanced CNC milling programme

A four day course exploiting the use of CAD/CAM for 3D CNC milling processes. Explore advanced cutting strategies employed by CAM systems. This is a practical "hands on" course with machining & computer activities.

5 April Principles of heat treatment

This course outlines the basic metallurgical principles of heat treatment, the fundamentals of furnace design and operation and concludes with an explanation of testing and quality control procedures.

12 April Stainless steel metallurgy

A one day technical course covering all aspects of the production and use of a range of stainless steel alloys.

25-28 April Advanced CNC turning programme

A four day advanced course for CAM programming and production on CNC turning centres and typical applications in today's modern engineering environment.

26 April Testing techniques

A technical course describing the techniques used to determine the mechanical properties of metals and for non-destructive testing (NDT) of structures and components.

New partners at the AMRC with Boeing



Bharat Forge Limited, the Pune based Indian multinational is a technology driven global leader in metal forming having transcontinental presence across nine manufacturing locations, serving several sectors including automotive, power, oil and gas, construction and mining, rail, marine and aerospace.

bharatforge.com



Blaser Swissslube develops, produces and sells high-quality metalworking fluids. Blaser's metalworking fluids are used to produce a range of parts – tiny parts for the watch-making, demanding parts in the medical industry, huge structural elements for the aircraft industry and mass produced critical automotive parts.

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