midlands aerospace alliance

The new technology catalogue

Great ideas for better aircraft and better manufacturing from companies in the aerospace supply chain

Welcome

The Midlands is home to one of the largest aerospace industry clusters in the world. The times ahead are challenging. We're seeing an unparalleled growth in the number of aircraft being manufactured, experiencing uncertain economic conditions and facing intense global competition.

David Danger, Chair

Peter Smith, Vice Chair

At the heart of any solid plan to get ahead and grow are great ideas. Right across the supply chain. That's why the MAA is proud to be celebrating ten years of enabling aerospace businesses, mostly our smaller companies, to access over £8m of funding and develop more than 40 new technologies for new and next generation aircraft.

It's sometimes assumed that lower-tier aerospace companies should focus solely on efficiency initiatives and have less to contribute when it comes to innovation and new technology. The truth is, these companies often have great ideas but lack the resources to develop them. With the right support, innovative thinking can be developed and take off. You'll read inspiring examples of how the MAA has enabled this to happen in this catalogue. There'll be more stories like this to come as we explore new ways of working together in the Midlands to maximise the development of new technologies for the world's aerospace industry into the future.

Companies across the Midlands aerospace supply chain are in constant competition to be positioned on tomorrow's aircraft programmes. Developing new capabilities, processes and technologies is vital to stand out. To enable more of our companies to do this, the MAA's unique philosophy of support addresses all the key things these companies need, and tackles all the barriers which could get in the way, at once.

Andrew Mair, Chief Executive

We're passionate about helping supply chain companies create their own intellectual property and especially to turn their fantastic technical knowhow into knowledge they can exploit commercially by helping solve challenges the big aircraft and engine makers face. If there's one thing I've learned, over the ten years the MAA has been supporting brilliant companies like those you'll see featured in this catalogue, it's just how deep the well of new ideas is within the aerospace supply chain and especially within small manufacturers. It's a privilege to be part of helping transform these concepts into real competitive advantage.

Take G&O Springs, for example, a high-performing spring manufacturer which was one of the early companies to receive support through our ATEP programme a decade ago. The company now possesses IP for spring design critical for better performing actuation systems, has secured new customers that recognise its expertise – and sales have more than doubled.

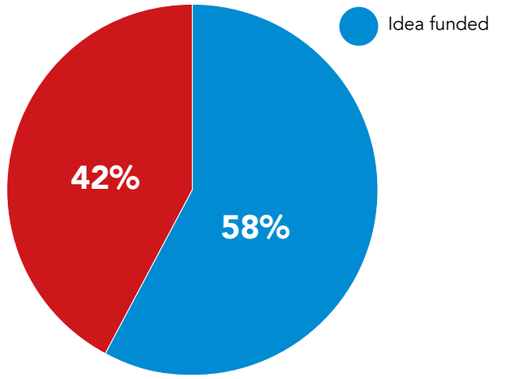
Over the following pages, you'll discover the innovative way we work with aerospace companies at all levels to develop new product technologies and better manufacturing processes. I hope their success stories will inspire you to work with them on your new aerospace projects and to talk to our team if you have fresh ideas of your own which you're considering developing.

Companies get real results

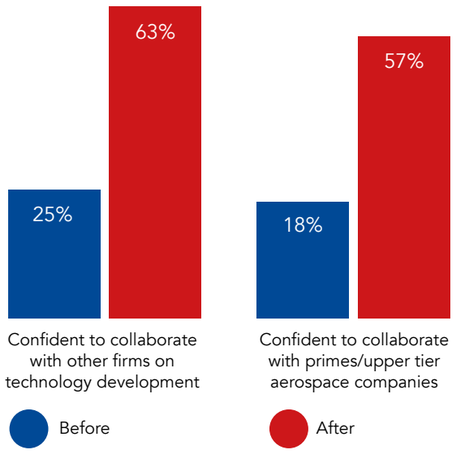
Many of the technologies we've supported supply chain companies to mature will be used on current and next generation aircraft programmes or help manufacture them better. They also help the companies that developed them improve productivity, reduce costs and create more jobs by winning more work with existing and new customers around the world.

> "It really helped that my MAA Technology Manager understood my technology. This helped get my idea down into a convincing and successful application."

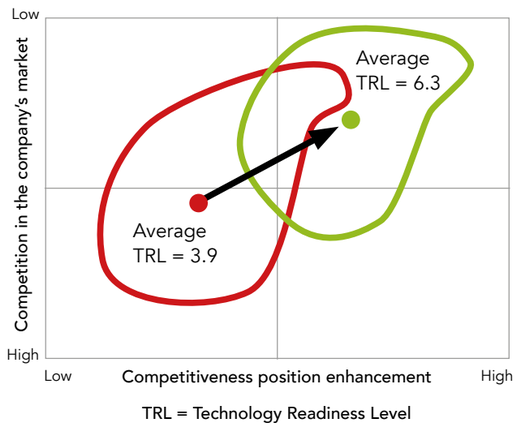
The MAA approach means a high rate of project acceptance



Aerospace suppliers grow in confidence

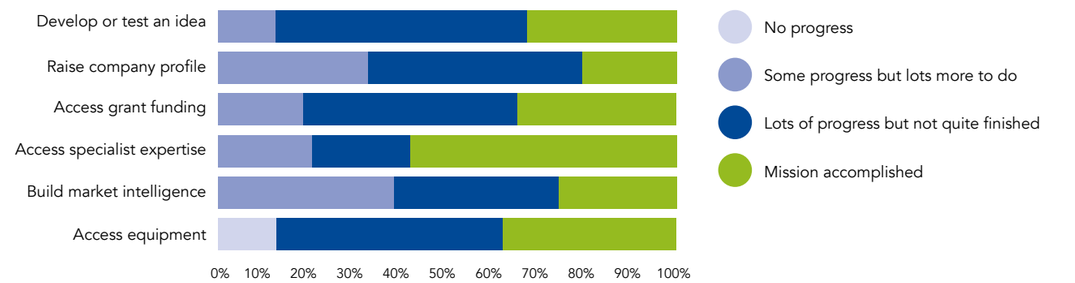


Companies' competitiveness is enhanced



Source: Evaluation of NATEP technology development programme by Regeneris Consulting

Companies achieve or make good progress towards their goals



Source: Evaluation of NATEP by Regeneris Consulting

Support at the highest level

Top companies within the aerospace sector get actively involved with our work. We value the time they provide for inputting into strategic development and supporting supply chain organisations.

For example, over 75 leading aerospace companies, including Airbus, Boeing, Rolls-Royce, GKN and BAE Systems, have advised supply chain companies as part of one of the technology development programmes we designed, NATEP.

Rolls-Royce

"We need to develop a lot of technology across a wide range of fields," says Robin Hill, Head of Electronics at Rolls-Royce. "Obviously we can't possibly do it all in house."

He says the programme's reach into the supply chain through regional aerospace alliances is crucial. He values the Technology Managers who take on the detailed management of projects and work with companies like Rolls-Royce to ensure the requirements of end-customers are satisfied.

He would "absolutely" support further NATEP projects and is interested right now in "how we can continue to stimulate the supply chain."

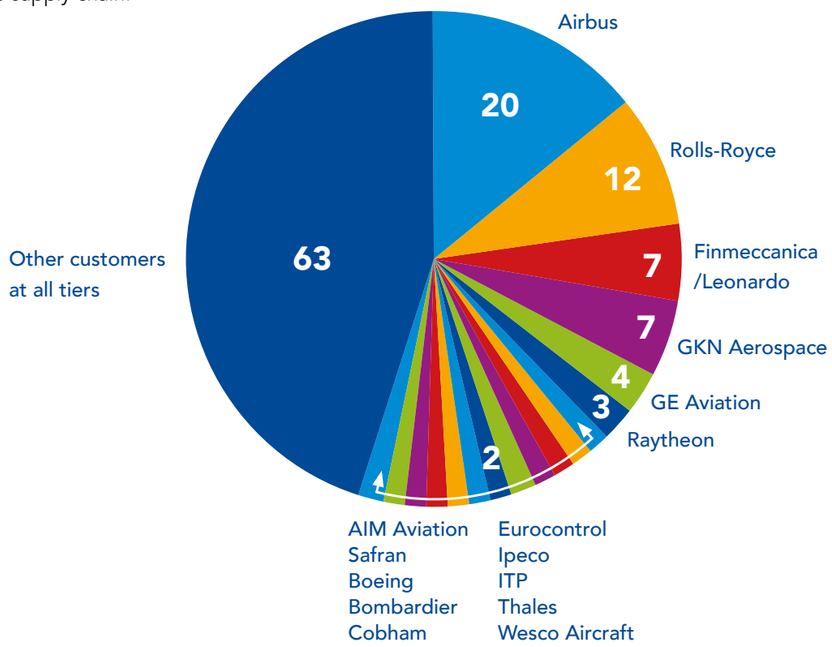
GKN

"NATEP has been a very exciting activity," says Jim Godman, Global Head of Engineering Integration at GKN Aerospace. "We've been very successful but it's only the start of the journey. We need to continue."

Meggitt

Toby Hutton, Manager of Friction and Structural Materials at Meggitt, was involved with an ATEP project, researching ways to increase brake life on aircraft, as part of the funding programme that was a precursor to NATEP. He then joined the MAA's Technology Group to advise on NATEP in the Midlands and found it rewarding.

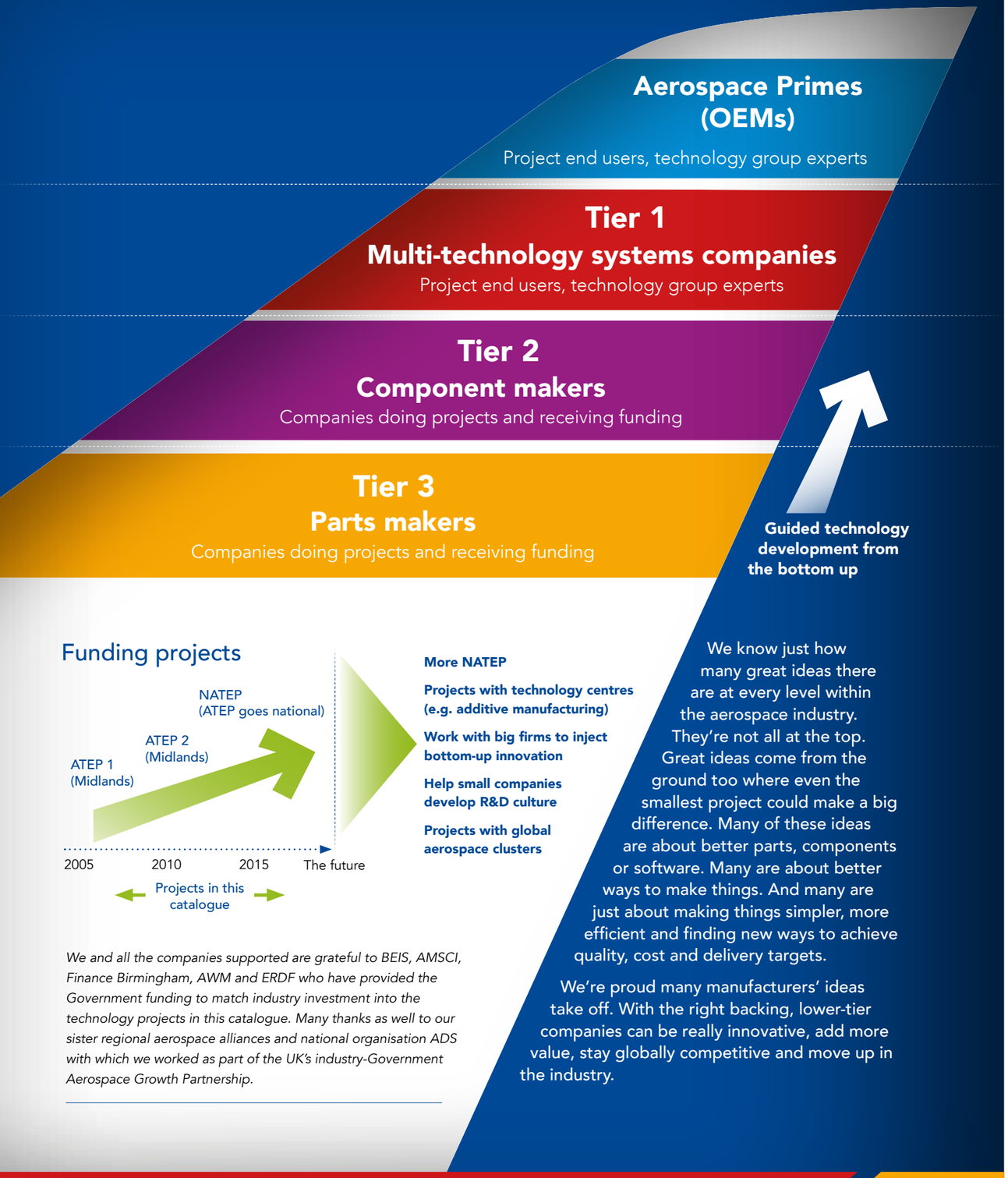
"The MAA's approach is excellent at drawing in SMEs and sometimes larger organisations that might have not considered aerospace before," he says. "The expertise that the MAA supplies gives these firms confidence and a vehicle through which to drive their R&D. NATEP has brought impactful benefits to the aerospace sector in the UK as well as the wider UK economy."



Dozens of aerospace companies have been end-users for projects, from Airbus that supported 20 NATEP projects to 63 that supported one project.

Source: NATEP

We help ideas take off



Funding projects

More NATEP

Projects with technology centres (e.g. additive manufacturing)

Work with big firms to inject bottom-up innovation

Help small companies develop R&D culture

Projects with global aerospace clusters

We know just how many great ideas there are at every level within the aerospace industry. They're not all at the top. Great ideas come from the ground too where even the smallest project could make a big difference. Many of these ideas are about better parts, components or software. Many are about better ways to make things. And many are just about making things simpler, more efficient and finding new ways to achieve quality, cost and delivery targets.

We're proud many manufacturers' ideas take off. With the right backing, lower-tier companies can be really innovative, add more value, stay globally competitive and move up in the industry.

We and all the companies supported are grateful to BEIS, AMSCI, Finance Birmingham, AWM and ERDF who have provided the Government funding to match industry investment into the technology projects in this catalogue. Many thanks as well to our sister regional aerospace alliances and national organisation ADS with which we worked as part of the UK's industry-Government Aerospace Growth Partnership.

Technology experts enable success

We have industry experts working at every level. Our board and three working groups are made up of a fantastic network of over fifty senior aerospace figures. The MAA Technology Group steers the MAA's work on technology development, gives valuable advice on individual projects and takes pride in seeing the results!

Our team of Technology Managers mentor companies at every stage. They are always on the lookout for problems that need solving and great ideas that may be eligible for financial and expert support. They also help businesses fine-tune their proposals and apply for funding. Then they work with companies to develop the new technologies and new manufacturing processes that will enable them to advance.

Technology Managers always work with companies in a collaborative way. Not only do businesses benefit from their project management expertise, for example, but the Technology Managers also encourage fruitful partnerships between companies, universities and research organisations and help them get the attention of potential customers.

Bridget Day

Bridget leads the team. She combines thirty years' experience working as an aerospace engineer with ten as a Technology Manager at the MAA to help the companies she mentors gain confidence and flourish. She's currently exploring additive manufacturing and digital factory enhancements.

Stan Payne

Stan is the MAA's go-to expert for technology roadmapping and helps companies to recognise and develop their innovation strategy and find clear paths to commercial exploitation of their technologies. He particularly enjoys using his business acumen to help companies achieve their wider objectives through this process.

Malcolm Diplock

Malcolm enjoys seeing projects through from concept to completion, especially when the lead partner goes on to establish an ongoing relationship with an aerospace prime end-user, as it can create new opportunities for them.

Eric Bray

Eric appreciates the uniqueness of each of the companies he supports as well as the variety of technologies and challenges with which he's involved. He likes helping companies move forward into the next stage of their journey.

Dr Pamela Farries

Pamela gets great satisfaction from discovering overlooked technologies, sometimes from different sectors, and bringing them to aerospace. At the moment, she's excited by research into better energy storage, potentially for electric aircraft and hybrid flight.

Peter Knight

Peter has spent most of his career working in R&D and joined the MAA after serving as a member of the MAA Technology Group in his previous job. Peter brings his experience and enthusiasm for developing technology to smaller organisations. He values the way the MAA cares for the long-term viability of the aerospace supply chain and is committed to supporting this task.

midlands aerospace alliance

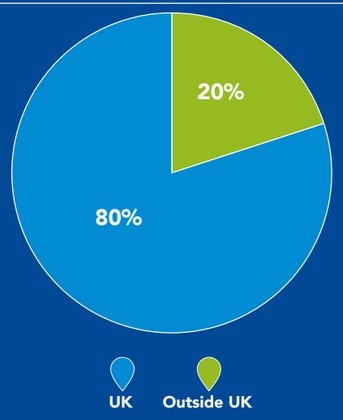
MAA projects deliver locally and globally

Naturally, most of the technology projects we've supported are based in the Midlands. We support companies outside the Midlands too, if they are partnering with a Midlands company or don't have a regional aerospace alliance where they are located.

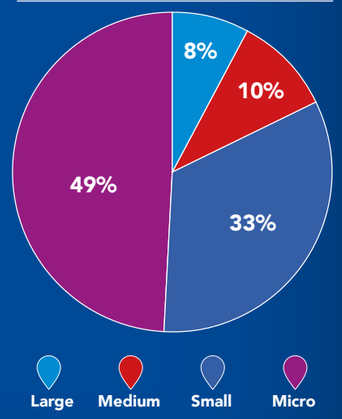
The results will make their way across the globe on new and next generation aircraft.

Companies across our region participate in MAA new technology projects

MAA promotes future exports with 1 in 5 end users outside the UK

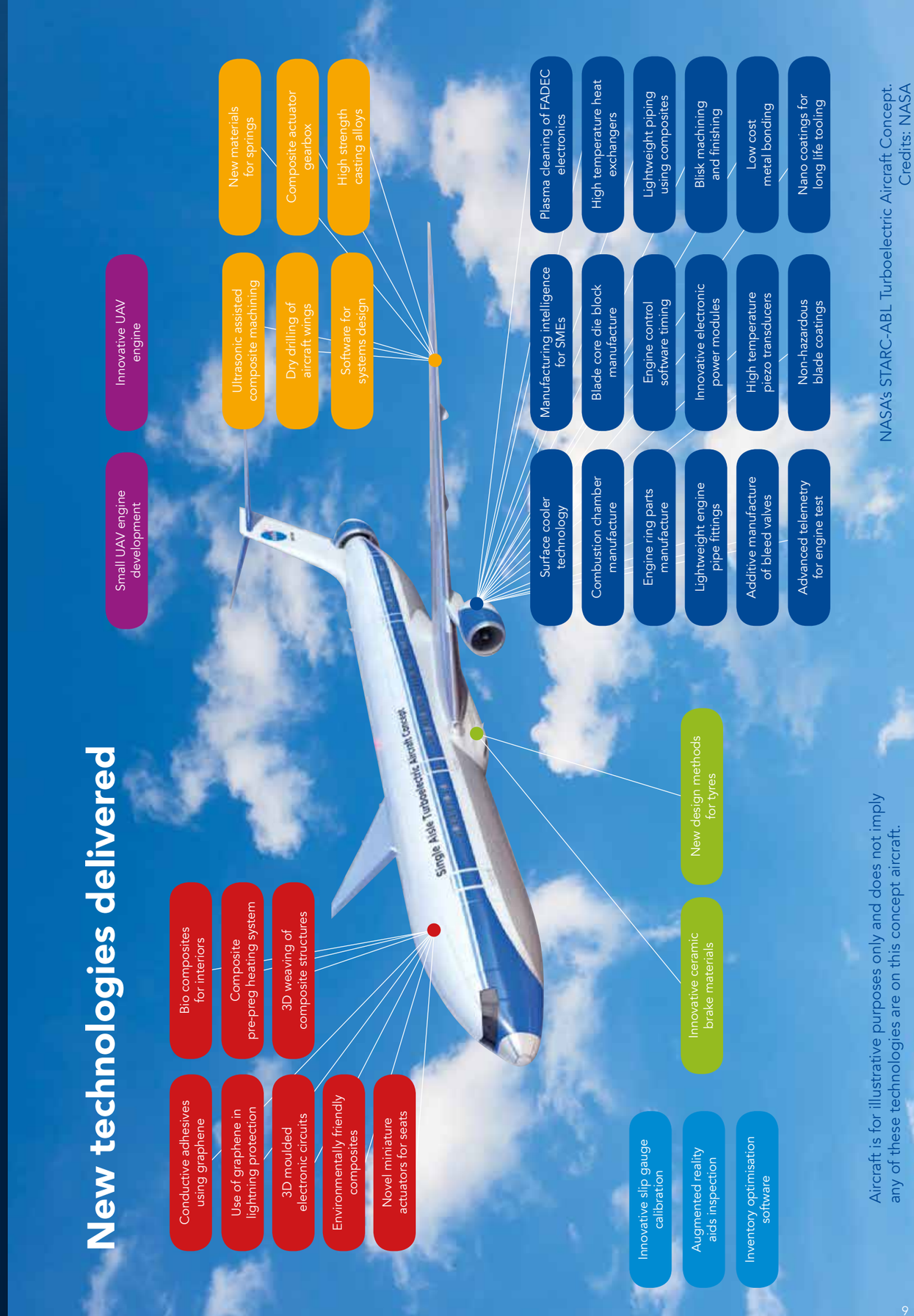


MAA supports smaller companies



Source: NATEP participants

New technologies delivered



NASA's STARC-ABL Turboelectric Aircraft Concept. Credits: NASA

Aircraft is for illustrative purposes only and does not imply any of these technologies are on this concept aircraft.

Project Catalogue

	Page	Electronics	Manufacturing/Processing	Software/Modelling	Composites	Actuators/Sensors	Additive Layer	Engines	Materials	Instrumentation/Metrology	Coolers/Heat Exchangers
Process Optimisation for Aerospace Alloys	11		●								
Visual Inventory Optimisation System	12			●							
Lightweight Pipe End-Fittings	12		●				●				
Inhibiting Delamination in CFRP Composites	13				●						
Additive Aero Valve Optimisations (AAVO)	13		●				●				
Xenon Pulse Technology in Fibre Placements	14				●						
Hands-Free Inspection Interface	15			●							
ROCA: RapiTime Object Code Analyser	15			●							
Configurable Double-Sided Cooled Integrated Power Module	16	●									
Plasma Cleaning in MCM Advanced Manufacture	16	●	●								
SPARCS Rotary Engine	17							●			
Machine Connectivity and Manufacturing Intelligence	17		●	●						●	
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3D Moulded Circuits	20	●	●		●						
Chrome free Ipcote	21		●								
Enterprise Bio-Interiors Project	21				●						
Dry Drilling of Aluminium Alloys	22		●						●		
Finite Measurement	23									●	
Combustion Chamber Process Innovation	23		●					●			
Graphene-Enhanced Adhesive Technology through Functionalization (GrEAT Fun)	24								●		
High Temperature Heat Exchanger	24		●								●
Composite Pipe Bending	25		●		●						
Heat Transfer Surface Development	25		●						●		●
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Integrally Bladed Rotor (IBR) – Barrel Milling Cutter	29		●								
Software Defined Telemetry	30	●	●								
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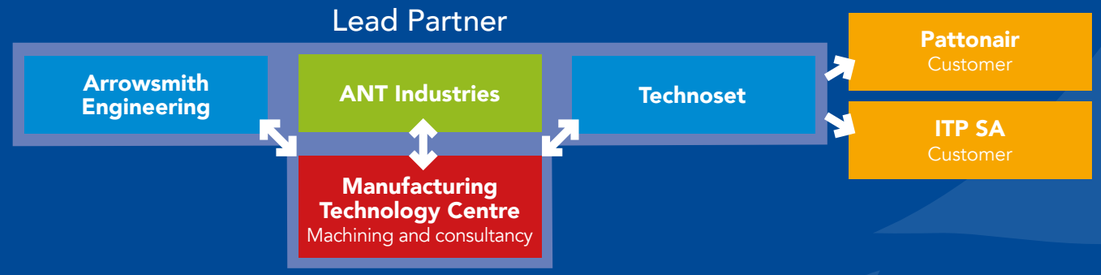
Aircraft Tyres Finite Element Modelling	32			●							
Aerospring Spring Characterisation	32		●						●		
Biocomposites for Aerospace Interiors	33				●						
Endurance Braking	33					●					
Integrally Bladed Rotor (IBR) – Abrasive Flow Machining	34		●								

Process Optimisation for Aerospace Alloys



When MAA members ANT Industries, Arrowsmith Engineering and Technoset faced manufacturing challenges on precision aerospace make-to-print parts, they realised that NATEP could be an opportunity to help differentiate themselves from their competitors. By embracing a culture of R&D to produce innovative solutions, the partners demonstrated how they can add value for their customers. Under this project they formed a consortium with the Manufacturing Technology Centre (MTC) in Coventry to tackle two specific problems; the machining of large diameter, very thin section aero engine rings for end user ITP SA, and thread rolling in ultra-hard materials for end user Pattonair.

ANT Industries machine many parts for aero engines including large diameter, complex section engine rings, where the wall thickness can be as little as 1-2 mm. This presents major challenges due to material relaxation and distortion meaning that it is difficult, and in some cases impossible, to produce parts within drawing tolerances, resulting in the need for concessions. With assistance from ANT Industries, MTC carried out 'off-line' research into machining, tooling and fixturing strategies, and how these affect component stability and relaxation. For Managing director Shaun Rowley this lead to a more generic understanding of how to produce a whole family of similar parts, and the securing of a long-term contract for rings on a new engine series. "It's always a challenge for an SME to find the time for R&D. When you can sit with a team of experts, you get new ideas that challenge what you do. For us, that was a bonus."

Arrowsmith asked MTC to help solve manufacturing problems associated with the thread-rolling of ultra-hard aerospace alloys. By again carrying out off-line research into the thread rolling process, machinery and tooling, MTC were able to help Arrowsmith write a set of manufacturing standards that would enable them to consistently produce conforming parts. Managing Director Jason Aldridge feels it is important that the UK aerospace supply chain demonstrates its commitment to finding advanced solutions at every stage of manufacturing. "As a result of this project, we will be manufacturing components that previously could not be made, and we'll be using precision controlled production techniques that keep quality high and costs down".

Contact: Jason Aldridge – jason@arrowsmitheng.co.uk

Visual Inventory Optimisation System

Lead Partner

CANDA Systems Software coding ⇔ **Consult Avila** Software spec and test ⇨ **RLC Engineering Group** Customer

Maintaining stock levels of aerospace components and materials at the optimum levels can be a problem, especially when this involves high part counts, many expensive parts, multiple sites, legacy parts, different customer programmes and contractual commitments, with varying call-off rates and replenishment lead times.

MAA member Consult Avila and its partner CANDA Systems have tackled this problem by developing a new visual management software tool (VIOS) to optimise inventory, with guidance from end-user RLC Engineering Group. VIOS provides users with data visualisation screens allowing dynamic inventory planning and control, incorporating best practices in inventory management such as trend analysis, alerting, forecasting, financial planning, and automated replenishment. The grant enabled a prototype version of the VIOS software to be demonstrated to prospective customers and, assisted by valuable feedback from users, a full commercial version of the software has now been produced with production partner ValueChain Technology.

Consult Avila chief executive Jose Guzman-Bello comments: "Our approach is designed to change the way of working and create a new way of thinking. Inventory is a symptom and not the disease."

Contact: Dudley Wood – dudley.wood@consultavila.com

Lightweight Pipe End-Fittings

Lead Partner

3T RPD Additive layer manufacture ⇔ **Sigma Precision Components** Design, machine, test ⇨ **Aerospace Company** Customer

The objective of this 12-month project, led by MAA member Sigma Precision Components, was to reduce aircraft weight by designing and manufacturing a new range of lightweight pipe end-fittings, taking full advantage of the benefits offered by the metal additive layer manufacturing (ALM) process. Working with partner 3T RPD, it soon became clear to project leader Sigma that its design team would need additional training in order to take full advantage of the exciting possibilities offered by ALM technology.

The NATEP grant enabled the partners to redesign and build a selection of typical complex end-fittings – including T and Y pieces, instrumentation fittings, flanged fittings and elbows – which were subjected to rigorous analysis and testing to validate both materials and processes. Sigma's Director of Technology & Improvement, Mike Andreae, reported: "The results show the new end-fittings are at least 50% lighter than current designs and, in some cases, more efficient due to improved flow characteristics."

Contact: Mike Andreae – michael.andreae@sigmacomponents.co.uk

Inhibiting Delamination in CFRP Composites

Lead Partner

Composite Innovations Composite tooling ⇔ **M Wright & Sons** 3D composites ⇨ **GKN Aerospace** Customer

Carbon fibre reinforced plastic (CFRP) composite structures which use conventional two-dimensional woven fabric layers can fail through de-lamination at the inter-ply boundaries when subjected to impact or cyclic loads. Typically the introduction of through-thickness fibres which bind the plies together results in reduced mechanical properties due to crimping of the in-plane reinforcing fibres.

In this 2 year project, M Wright & Sons together with moulding partner Composite Innovations have developed a 3D weaving capability which results in 'near-zero' crimping of the reinforcing fibres, leading to 3D preform structures which exhibit increased resistance to delamination whilst maintaining good in-plane mechanical properties. Various test shapes have been produced, including T-section beams, which have been subjected to a range of mechanical tests with excellent results. End user GKN Aerospace is looking at how this technology can be incorporated into its composite aerospace components.

M Wright project leader, Simon Marshall, comments; "The development of 3D weave architectures allows the manufacture of composite structures with increased resistance to interlaminar failure due to impact or cyclic loading. In addition, near crimp-free architecture creates laminates with excellent in-plane mechanical properties. This allows engineers the flexibility to design structures with high damage resistance without compromising in-plane mechanical properties".

Contact: Simon Marshall – smarshall@mwright.co.uk

Additive Aero Valve Optimisations (AAVO)

Lead Partner

Ashton & Moore Finishing ⇔ **Meggitt Aerospace** Design and manufacture ⇨ **GE Aviation** Customer

Suppliers of aerospace components and systems are under constant pressure to reduce the cost and weight of components, whilst improving performance. In this project, Meggitt Control Systems set out to develop a fully-optimised jet engine compressor bleed valve by taking advantage of the design freedoms of additive layer manufacture (ALM).

Bleed valves vent the compressor during low power operation to prevent engine stall. Venting of the compressor contributes significantly to the engine noise. By beginning the valve design with the basic functional specification, it became possible to integrate silencing measures into the valve design, reducing the complexity of the bleed air system. The integration of components and functions into single parts reduces technical, commercial and supply chain challenges. The result was a lighter, quieter, more reliable and more efficient valve with a reduced cost of manufacture.

Project leader Scott Lathrope comments: "For Meggitt, the critical output of this project is the design-for-process lessons when ALM is utilized in system development. The result is a process for a broader approach to product design."

Contact: Scott Lathrope – scott.lathrope@meggitt.com

Xenon Pulse Technology in Fibre Placements

Lead Partner

Hexcel
Composite Material

Heraeus Noblelight
Xenon Technology

Rolls-Royce
Customer

Cambridge-based Heraeus Noblelight used NATEP funding to help it demonstrate the use of xenon flash technology as a highly controllable heat source in automated fibre placement (AFP) when laying up composite materials for aerospace applications. Together with partner Hexcel Composites, project leader Heraeus has taken the idea from a basic laboratory test bench demonstrator to a fully working system fitted to a Coriolis composite fibre placement machine at the National Composites Centre, Bristol, under the watchful eye of end user, Rolls-Royce. This patented technology, which offers significant advantages over competing laser and infrared-based systems has been branded as humm3 and is now winning orders from equipment OEMs.

According to Heraeus Technical Director Jeremy Woffendin, "This new technology is generating strong commercial interest from the aerospace sector, with additional opportunities in other market sectors. We're now working with key equipment OEMs to fully integrate our system into their products." He added: "NATEP helped us to develop the system in a timely fashion and lowered the financial risk; it has enabled us to create new jobs at Heraeus whilst securing jobs for the existing workforce, and put the UK firmly in the lead for this technology".

By Coriolis Components

Contact: Jeremy Woffendin – jeremy.woffendin@heraeus.com

Hands-Free Inspection Interface

Lead Partner

Coventry University
Human factors

Muretex
System development

Cranfield Aerospace
Customer

Major Aerospace Tier 1
Customer

In this project led by Muretex, the partners have investigated the use of an optical head-mounted display system to provide 'hands-free' aerospace inspection and assembly instructions without reference to printed materials. The NATEP grant enabled the partners to develop the infrastructure and processes necessary to serve up work instructions in a readily assimilated manner, reducing operator workload and improving efficiency, accuracy and traceability. Trials at Coventry University were commissioned to demonstrate the benefits of using a head-mounted display system over the use of traditional paper and electronic work instructions

Based on the experience gained with the NATEP demonstrations, Muretex has launched its Augmentor® service which offers bespoke solutions aimed at augmenting human capabilities through the use of technology. Founding Director, Jon Platts comments: "The project enabled us to rapidly build the kernel of the system against realistic use-cases and whilst the grant funding is extremely welcome, the gravitas of a NATEP funded project was equally valuable and allowed us to access key end-users."

Contact: Jon Platts – jtplatts@muretex.com

ROCA: RapiTime Object Code Analyser

Lead Partner

University of York
Certification consultancy

Rapita Systems
Software development

Rolls-Royce
Customer

Airbus Defence and Space
Customer

How long does it take for safety-critical aerospace software to run, particularly in 'worst-case' scenarios? This is a question that all suppliers of aero engine control software such as Rolls-Royce must be able to answer with certainty as part of the certification process.

Until now, timing measurements have been obtained by 'instrumenting' the code using Rapita Verification Suite (RVS), which involves an extra tooling step, and has an impact on execution time. A theoretical solution to avoid this step was put forward in a PhD thesis in 2011, but implementing it required investment and hardware support, not to mention a good measure of innovative thinking. With funding from NATEP, aerospace software verification specialists Rapita, working in collaboration with the University of York, has produced a demonstration version of its Rapita Object Code Analyser (ROCA) for RapiTime, which eliminates the need to instrument source code. ROCA can reduce the effort and cost needed to perform timing verification by 25%.

Rapita CEO, Dr Guillem Bernat comments: "NATEP gave our project a platform that brought it to the attention of two end users, Rolls-Royce and Airbus Defence and Space. Both companies were involved in our research and their input was invaluable to ensure we developed a demonstrator that met their exact needs".

Contact: Ian Broster – ianb@rapitasystems.com

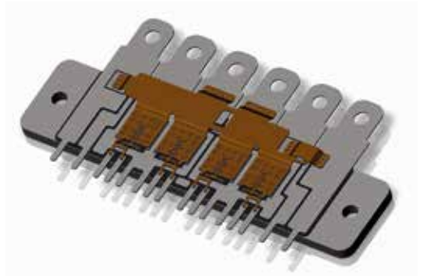
Configurable Double-Sided Cooled Integrated Power Module

Lead Partner

Pre-Met
Copper retaining clips design and manufacture

Semelab
Design, manufacture, test

Rolls-Royce
Customer



For the Leicestershire-based semiconductor specialist Semelab, part of the TT Electronics Group, R&D underpins its corporate culture as it seeks to keep ahead of the market and maintain its status as an expert in its field. Under this 18 month NATEP project, Semelab and project partner Pre-Met designed and manufactured a new configurable and highly thermally efficient electronic power module for end user, Rolls-Royce. This module uses a unique architecture to provide significant improvements in heat dissipation, reliability, performance, and ease of integration, whilst reducing cost, size and weight.

Semelab Engineering Director Julian Thomas commented that although the company is no stranger to match-funded R&D, the MAA's approach brought unexpected business benefits. "One of the good things was the workshops they arranged, particularly sessions on intellectual property (IP) and road-mapping. These types of business level workshops are very useful, especially for SMEs."

Contact: Julian Thomas – julian.thomas@semelab-tt.com

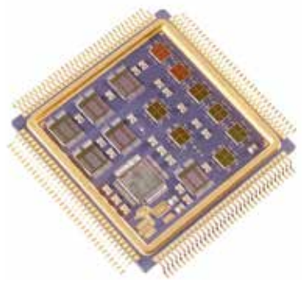
Plasma Cleaning in MCM Advanced Manufacture

Lead Partner

Accelonix
Plasma cleaning

Welwyn Components Power & Hybrid
MCM manufacture

Rolls-Royce
Customer



Northumberland-based Welwyn Components, a division of TT Electronics, is on a journey of increased automation within its production line for Multi-Chip Modules (MCM), a form of integrated hybrid electronics. One key aspect in ensuring the necessary high levels of reliability for these often safety critical products is cleanliness, particularly prior to die placement and wire bonding.

The aim of this project was to investigate whether automation of the production line could include in-line plasma cleaning of the substrate. Although an established process in other industries, the use of plasma cleaning in safety critical applications has historically been discouraged because of fears of surface damage. This project investigated the effects of plasma cleaning on an MCM that is used to control aero engines and flight management systems, a flagship component for Rolls Royce engines.

TT Electronics Engineering Director, Julian Thomas, comments: "Working with partners Rolls-Royce and Accelonix, Welwyn Components were able to show categorically through this NATEP project that plasma cleaning presents a viable solution which can safely be incorporated into the automated MCM line."

Contact: Julian Thomas – julian.thomas@semelab-tt.com

SPARCS Rotary Engine

Lead Partner

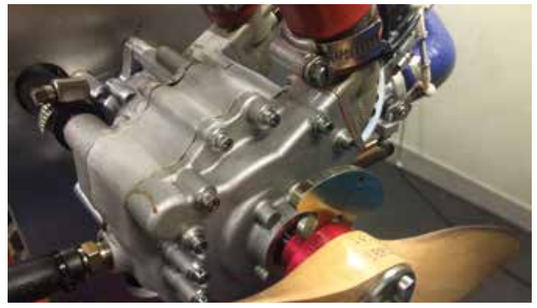
Vortex Exhaust Technology
Exhaust design, manufacture

Advanced Innovative Engineering
Design, build, test

Aero Composites Innovations
Customer

In this 18-month project led by Lichfield-based Advanced Innovative Engineering (AIE), the partners have developed a high-performance compact propulsion system for a new generation of commercial unmanned aerial vehicles (UAVs) designed by end user, Aero Composites Innovations. The project involved the design and manufacture of a small rotary engine which incorporates AIE's patented SPARCS rotor cooling system and a new exhaust system from Vortex Exhaust Technology. The result is an extremely lightweight engine which features better thermal control, gas sealing and exhaust cleanliness than competing engines.

The 5hp, 40cc engine is designed to power a small rhomboid-wing UAV, itself highly innovative. The compactness of the engine meant that many of the commercially available ancillaries were too large, requiring AIE to design and manufacture its own



miniaturised devices. AIE's Nathan Bailey comments: "This new engine hits a sweet spot in the market because it competes with both higher power electric UAV's which have endurance limitations, and less efficient small conventional internal combustion engines which generate unwanted vibrations for sensitive payloads".

Contact: Nathan Bailey – nathanb@aieuk.com

Machine Connectivity and Manufacturing Intelligence

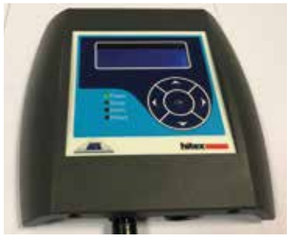
Lead Partner

Hitex (UK)
Embedded technology

ATS
System design and integration

Arrowsmith Engineering
Customer

The objective of this project from Applied Tech Systems (ATS) and partner Hitex was to bring the 'digital factory' within reach of SMEs. While larger companies are embracing the fully digital revolution with fully integrated software connecting every part of the manufacturing operation, smaller companies usually have limited resources and end up with a miscellany of digital and manual systems, often driven by legacy software and with poor interconnectivity.



The project partners have developed a cost-effective machine connectivity module (MCM) to monitor manufacturing processes, using retrofitted sensors, wireless communications and embedded windows data processing and Android wifi display platforms. So-called credit card technology enables them to install low-cost data gathering on manufacturing machinery which will communicate via wifi with a server, offering the possibility of integration into the manufacturing intelligence network. End user Jason Aldridge of Arrowsmith Engineering has been a major advocate for this enabling technology. "The widening gap in digital maturity between higher and lower tiers in the aerospace manufacturing supply chain needs to be closed if our industry is to compete globally".

Contact: Greg Ella – greg.ella@ats-global.com

Novel Miniature Actuator (NMA)

Lead Partner

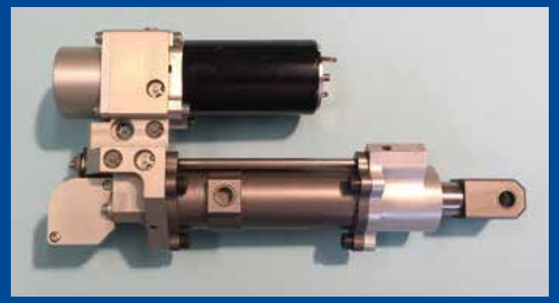
Midland Aerospace
Manufacture

↔

CNR Services International
Design, assembly, test

→

BE Aerospace
Customer



By Hideyuki KAMON from Takarazuka

Engineering design specialist and MAA member CNR Services International led this NATEP project to design, build and demonstrate a new actuator for first and business class aircraft seats. CNR Managing Director Chris Reckless said success in testing the 'Novel Miniature Actuator' to aerospace specifications points to a potential game-changer in its class. "The new device is smaller, lighter, cheaper and uses less power than its current counterpart. Once this gets productionised, the weight reduction alone will run into millions of dollars savings a year. It's a massive win for the operators."

Together with partner Midland Aerospace, which made one of the key components of this radically different actuator, CNR proved to its end user, BE Aerospace, that it was possible to 'swim against the stream' and re-think the design concept completely rather than keep refining an existing concept.

Contact: Chris Reckless – creckless@cnrdesign.co.uk

Proof of Systems Assurance and Certification

Lead Partner

Abstract Solutions
SysML programming

↔

D-RisQ
System design and Modelworks 'engine'

→

GE Aerospace
Customer

As the avionics industry moves towards the development of ever more complex systems, validation of software against requirements for aircraft certification purposes becomes a major challenge. Current techniques focus on manual review at the outset of the project and then, towards the end of the project, testing reveals any inadequacies of the system against the requirements. This process is inevitably error prone and costly, especially when errors are discovered late in a project. This problem led software specialists D-RisQ and Abstract Solutions to propose a NATEP project in which a new tool would be developed that can automatically verify that requirements for a system have been fully and accurately captured early in the design phase, with a high level of confidence.

Based on D-RisQ's underpinning Formal Methods technology, the new tool incorporating the SysML modelling language as a 'front end' takes system requirements expressed in English, converts them to a formalised representation expressed in SysML and then uses the Formal Methods technique to validate that the requirements have been fully and accurately captured. D-RisQ's Business Director Nick Tudor comments: "Whilst the methods used are generic, the intention is that this tool can be qualified for use on safety critical aerospace applications conforming to DO178C Level A."

Contact: Nick Tudor – njt@drisq.com

Graphene Composites Evaluated in Lightning Strike (GraCELS)

Lead Partner

SHD Composites
Resin and prepeg

Cobham Technical Services
Lightning strike testing

→

Haydale Composite Solutions
Functionalised graphene and project management

→

Airbus UK
Customer

BAE Systems
Customer

Use of composites in aircraft applications such as fuselage, leading edges and wing surfaces is complicated by the fact that the materials are very poor electrical conductors, especially in the laminate through-thickness direction, and so perform badly in lightning-strike events. To provide protection against lightning strike designers need to specify the incorporation of additional materials such as copper mesh; this, however, adds cost and weight to the aircraft.

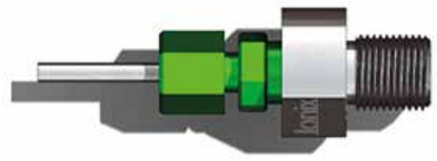
In this 18-month NATEP project, composites specialist Haydale Composite Solutions, together with partners SHD Composites and Cobham Technical Services, have come up with a novel solution which involves the incorporation of graphene/2D nano-particles into the composite resin. The key to success lies in the efficacy of dispersion of the nano-fillers throughout the resin, and here Haydale's patented plasma functionalisation technique has allowed composite panels to be developed with significantly improved through-thickness electrical conductivity. Sample panels have been subjected to 'laboratory lighting strike' by lighting testing specialists at Cobham Technical Services. Project Leader Peter Hansen is enthusiastic about the possibilities for this technology. "Whilst we still need to undertake further research, we have achieved some very encouraging results which have generated significant interest within the aerospace sector."

Contact: Peter Hansen – peter.hansen@haydalecs.com

Piezoelectrically - Enabled Aero Controls

Lead Partner

Linwave Technology Signal processing ⇔ **Ionix Advanced Technologies** Design, build, test ⇨ **Rolls-Royce** Customer



Although piezoelectric transducers have been around for many years, until recently the temperature limitations of the material have precluded their use in instrumentation on gas turbine engines. All that is about to change with a new 'high temperature' piezoelectric material developed by Ionix Advanced Technologies from original research undertaken by the University of Leeds. Working with partner Linwave Technology, Ionix have initially concentrated on the development of a piezoelectric displacement transducer which would replace a linear variable differential transformer (LVDT) position sensing device currently used on gas turbine engines. The new device is designed for operation at temperatures up to 350°C for 25,000 hours. Much of the work has centred around encapsulation of the piezo material to make it rugged even when immersed in fuel.

There has been strong interest from end user, Rolls-Royce, and project leader Tim Comyn of Ionix believes there is also a strong market pull for the high temperature piezo-electric devices in non-aero markets. "We are commencing broad commercial release of technology based on this transducer in a range of sectors including petrochemical and nuclear."

Contact: Tim Comyn – tim.comyn@ionix.at

3D Moulded Circuits

Lead Partner

Moulded Circuits Plated polymers and composites ⇔ **Laser Optical Engineering** Holographic diffractive optics ⇨ **MBDA UK** Customer

This NATEP project gave Laser Optical Engineering (LOE) and partner Moulded Circuits a helping hand to develop a laser processing system capable of marking high resolution circuity onto engineering polymer parts. With guidance and encouragement from end user, MBDA, the team have developed a laser writing system capable of producing copper tracks or circuits on 3D polymer and composite structures. This allows such structures to become electrically functional components within a system, replacing the traditional circuit board. The technology will give designers scope to combine part functionality to reduce component count and weight, and allow much greater freedom to produce truly innovative designs.

The research developed two different, but complementary approaches to allow for different types of substrate and also the variation in feature sizes which might favour one particular approach. Using both additive (deposition) and subtractive (ablation) techniques, the team have been able to successfully apply 3D circuitry to trial structures provided by MBDA. LOE's Managing Director, John Tyrer, comments: "This partnership is well placed to take advantage of what we see as a large and expanding market for 'intelligent structures' and embedded functionality across a wide range of sectors."

Contact: Daniel Lloyd – enquiries@laseroptical.co.uk

Chrome-free Ipcote

Lead Partner

Ashton & Moore Spray system

Clean Burner Systems Precision heating

⇔ **Indestructable Paint Company** Coating development ⇨ **Messier Dowty** Customer

⇨ **Rolls-Royce** Customer

The Ipcote product manufactured by Indestructible Paint Company (IPC) is approved by a large section of the aeronautical industry as an erosion and corrosion-resistant coating for turbine blades, undercarriages and parts for high temperature applications. Whilst it is a replacement for cadmium plated products, IPC recognised that because the product was based on chromic acid, it was subject to fresh legislative threats. IPC have a representative on the European REACH committee. A previous feasibility study, also funded by ATEP, working with with CERAM (now Lucideon) researched the chemicals involved. This indicated that manganese redox agents could be a potential chrome replacement, with the benefit of offering lower curing temperatures. Building on the previous research the aim of this 18 month ATEP project was to reformulate Ipcote to be chrome-free. Partner Ashton & Moore was able to determine how the chemical replacements affected the spray application. Clean Burner Systems developed a highly focussed heating element normally used for curing tarmac, that in this project can be used to apply the chrome-free Ipcote product in situ on a runway if necessary. Thus a new chrome-free coating material and application/curing process was developed and successfully applied to test parts.

Enterprise Bio-Interiors Project

Lead Partner

AIM Aviation Manufacture and test ⇔ **SHD Composites** Product and process design ⇨ **Ipeco Composites** Customer

For Lincolnshire-based prepreg manufacturer SHD Composites, a new material set to revolutionise aircraft interiors has been developed using an unlikely biomass waste product. Under this 18-month NATEP project, SHD and partner AIM Aviation have developed a new composite material in which the phenolic resin that is traditionally used has been replaced by a furfuryl alcohol resin derived from waste by-products of sugar cane processing.

This new material has demonstrated great fire-resistance properties compliant with aerospace standards and mechanical properties which are as good as, or better than current materials. However, project leader Nick Smith emphasises that there are other benefits likely to be at least as interesting to the aerospace industry, concerning the health and safety of production workers and the environment. "The new material is much safer to handle as manufacture does not involve any hazardous volatile organic compounds (VOCs) and the hot melt manufacturing is less energy-intensive and solvent-free, leading to reduced emissions." SHD has acquired a new factory which will be used to manufacture the new prepreg material after it is certified.

Contact: Nick Smith – nsmith@shdcomposites.com

Dry Drilling of Aluminium Alloys

Lead Partner

Kyocera Unimerco Tooling
Tool design

Teer Coatings, MIBA Coating Group
Coatings development

Airbus UK
Customer

MAA members Teer Coatings and Kyocera Unimerco Tooling have been working together with the University of Manchester to explore tools for in-situ, liquid lubricant-free drilling on aluminium alloy aircraft structures. Tooling supplier Kyocera Unimerco had observed that dry, in-situ drilling of aluminium alloys, with no significant loss of drill tool performance, would simplify and reduce the cost of aircraft wing manufacture while also improving the workplace environment. For aircraft manufacturers like Airbus, using cooling/lubricating fluids during drilling adds to the complexity of manufacture, and the management of traditional lubricants in an open factory environment imposes additional complexity and cost. The idea of dry-drilling was shared with the MAA at the Farnborough Airshow, and Peter Knight, NATEP Technology Manager at the MAA, acted as technology broker, introducing Kyocera to supplier of advanced coatings, Teer Coatings, part of the Miba Coating Group. Airbus quickly came on board as end user, and a NATEP project was born.

Combining drill re-design and the application of advanced hard, solid lubricant coatings, the project team have been able to demonstrate that dry drilling is not only feasible, but a practical reality which fulfils the performance and commercial requirements. Dr Hailin Sun, R&D technology centre manager for Teer Coatings commented: "This project has been more than a collaboration, it's brought about a new business relationship, which is important as we see a great deal of potential for this technology, not just in aerospace".

Contact: Hailin Sun – hailin.sun@miba.com

Finite Measurement

Lead Partner

Coventry University
Robotics, electronics, software

Powerkut
Measurement hardware, testing

Winbro Group Technologies
Customer

Since the early 1900s, gauge blocks, sometimes referred to as slip gauges, have been widely used throughout the manufacturing industry as reference standards for calibration of instruments and measuring equipment. Coventry-based Powerkut, which provides a gauge block calibration service, realised that the labour intensive and highly specialised calibration procedure had changed little in the last 50 years or so. This did not seem compatible with current trends in manufacturing, as exemplified by Industry 4.0.

The objective of this 24 month project involving partners Powerkut and Coventry University was to automate the gauge block calibration operation. Removing manual handling of the blocks eliminates the need for thermal stabilisation, and automating the probing operations allows human interpretation to be replaced by highly repeatable machine measurement. Powerkut's Managing Director, Paul Bexon, comments; "This NATEP project helped Powerkut to develop its relationship with Coventry University, and provided an opportunity plus financial support to pursue some ideas on moving calibration technology forward."

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Combustion Chamber Process Innovation

Lead Partner

Hucknall Sheet Metal
Laser expertise

Nasmyth Technologies
Process development

Aerospace prime
Customer

For complex structures and precision welding company, Nasmyth Technologies, difficulties in manufacturing a make-to-print legacy combustion chamber component in a highly competitive market presented a difficult choice; this was to either decline the work, accept a high attrition rate arising in particular from three troublesome processes, or to invest in finding solutions, working with the customer to seek design changes where necessary. Nasmyth decided that, whilst the business case might not be very attractive, there was a strong case for helping the customer, which was committed to continued support of the engine. Fortunately help in the way of a grant from the NATEP programme was on hand.

Working closely with partner Hucknall Sheet Metal, Nasmyth carried out research into the three processes - welding, graphite bonding and thermal barrier coating of a perforated surface – all of which were having a negative impact on combustion chamber throughput. New alternative processes were successfully developed for each of these areas, which were presented to the customer. For Nasmyth Project Leader Mac Fletcher, the project had added benefits: "This project has helped show our customer that Nasmyth is more than a make-to-print company, and can add value through innovation. We firmly believe this underpins the development of a mutually beneficial long term relationship".

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Graphene-Enhanced Adhesive Technology through Functionalization (GrEAT Fun)

Whilst most adhesives make good electrical insulators, there are some situations, like ensuring earth bonding continuity between aerospace composite structures, where having a conductive adhesive would be beneficial. As aircraft designers are continually increasing the composite part count to reduce weight, challenges such as electrically conductive structural adhesives are becoming more important. There are examples of conductive adhesives on the market that use silver or other metallic fillers to increase conductivity but these are often of high density, expensive and the filler loading levels compromise the adhesion strength. In this NATEP project, partners Haydale Composite Solutions, SHD Composite Materials and Element Hitchin have investigated utilizing graphene's extraordinary electrical conductivity to produce conductive adhesives. The approach has the added benefit that the addition of graphene can also enhance the mechanical properties of the joint.

Project Leader Haydale's experience with a patented graphene processing technique called functionalisation has shown that structural adhesive resin systems can be developed with significantly improved electrical conductivity. Project Leader Peter Hansen of Haydale comments: "Our research into a number of different resin formulation systems has provided us with encouraging results. Although we still have work to do to reach the desired electrical conductivity levels, we have demonstrated anti-static adhesive pastes and films which are also attracting interest from our end user for other applications".

Contact: Peter Hansen – peter.hansen@haydalecs.com

High Temperature Heat Exchanger

In this project Wolverhampton-based H S Marston Aerospace worked with a Telford SME, Advanced Chemical Etching (ACE) to develop high temperature heat exchangers made from new alloys for aero engine applications. Both tubular and plate fin heat exchangers were manufactured in a material new to this market, new processes were developed for forming, brazing, welding. By manufacturing to existing designs a direct comparison could be tested. The new material and process developed extended the operating temperature of the heat exchangers by approximately 300°C. For ACE this project has led to a new business area and the development of a new laboratory for the hydrofluoric acid-free etching of titanium and nickel alloys.

Composite Pipe Bending

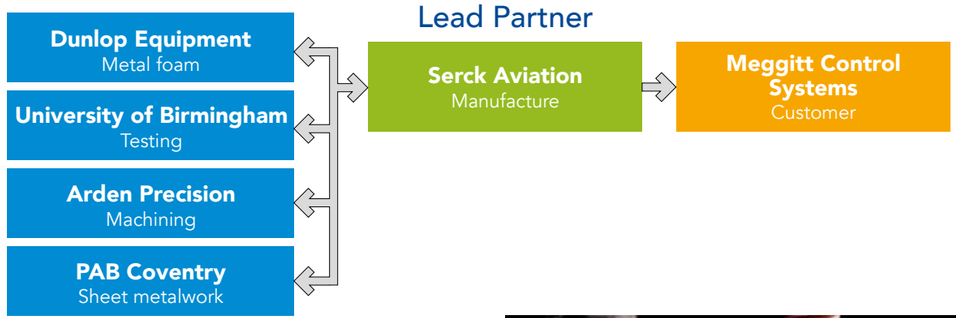
Carbon fibre reinforced thermoplastic pipes offer potential weight reductions for aircraft because they are durable, strong and light. The problem with airframe and aero-engine pipes, however, is that they are seldom if ever straight and more usually have bends in complicated 3D geometries. Traditional manufacture of thermoset composite parts, which involves laying the fibres in a mould replicating the final shape required, is problematic for pipes which can have many different shapes.

Leicestershire-based Sigma Precision Components, a leading supplier of metallic pipes, considered the traditional thermoset method neither a sensible nor cost-effective approach for composite pipes. Sigma proposed a novel alternative which NATEP has been able to help turn into a reality. In this 12-month project, Sigma and partner eMould (UK) have developed a process to bend pre-made Sigma composite straight pipe into the desired form under computer control. To achieve this, it was necessary to design and manufacture special tools which are heated and cooled during a precisely controlled, automated forming cycle.

The bent pipes have been subjected to a range of tests and have been shown to meet performance requirements. Sigma's Director of Technology & Improvement, Mike Andreae, said that interest from end users Rolls-Royce and Bentley Motors was strong. "Composite pipe is a disruptive technology which offers up to 50 per cent weight reduction compared to stainless steel and 15 per cent reduction compared to titanium. While only a proportion of aerospace applications would be eligible for a composite pipe solution due to thermoplastic temperature constraints, this is still a very large potential global market."

Contact: Michael Andreae – michael.andreae@sigmacomponents.co.uk

Heat Transfer Surface Development



Serck Aviation and Dunlop Equipment (now both Meggitt) worked with the University of Birmingham and two local SMEs - Solihull's Arden Precision (now Nasmyth) and PAB Coventry - to develop a manufacturing process to join metal foam to small tubes, which maximises the working surface within a small volume. The need to have a perfect joint for heat transfer is particularly challenging. The technology involved a novel nickel-based metal foam (Retimet) which has proved to be a more effective heat transfer medium in a range of environments inside and outside aerospace. A number of prototypes were manufactured and tested on a specially designed, fully instrumented water/air heat exchanger test facility at Birmingham University.

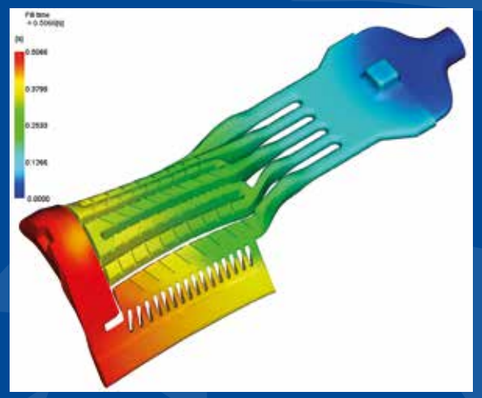
Cooled Core Die Blocks

Lead Partner

Material Solutions
ALM manufacture and support

Gardner BTC
Design, build, test, evaluate

Invest Tech
Customer



An 18-month NATEP project led by Gardner BTC featured the use of additive manufacturing (AM) to help improve the yield from one of the many complex manufacturing steps in making modern gas turbine blades. Turbine blades for aero engines are usually manufactured by investment casting (or lost wax processing) and a temporary embedded ceramic core is used to preserve the spaces which will eventually become complex internal air cooling galleries. For end user Invest Tech, manufacture of these ceramic cores presented a problem because the narrow and convoluted 'fingers' of the ceramic core were prone to fracture due to thermal stresses arising from heating and cooling.

Together with 3D printing partner Material Solutions, Gardner has redesigned the ceramic core manufacturing dies to introduce optimised thermal control within the die block during injection. The cooling channels were designed and positioned with the aid of computer thermal analyses to give greater control over the injection process and minimise residual stresses in the injected core. Gardner's Keith Fulford comments: "By using AM, it has been possible to make far more complicated internal pathways than have previously been achieved through conventional machining, giving our end user significantly better thermal control of their process."

Contact: Keith Fulford – kfulford@gardner-aerospace.com

Small Rotary Engine Technologies

Lead Partner

TechTeam Development
Assemble and test

ASNU Corporation Europe
Injection design, manufacture, test

A&M EDM
Design, manufacture, evaluate

UAV Manufacturer
Customer

For Smethwick-based precision machinists, A&M EDM, NATEP came at an opportune moment in the growth of the company. For many years A&M has manufactured parts of rotary engines for other companies, and has built up considerable experience in the manufacturing intricacies associated with this type of engine. However, the recruitment of design staff with significant rotary engine design experience, plus the chance to secure a grant, gave A&M management an opportunity to move from a make-to-print subcontractor to an engine OEM.

Working with a leading European UAV manufacturer, A&M identified a gap in the market for a small rotary engine with rapid starting when running on kerosene fuel, even at low temperatures. This project, which involved partners TechTeam and ASNU, resulted in the design, building and testing of a 11 kW rotary engine with excellent cold starting on heavy fuels, and an impressive continuous wide-open-throttle performance. Starting from a 'clean sheet' also meant that, in addition to the engine, the team needed to design and build a dynamometer cell test facility, plus most of the engine ancillaries. A&M's Managing Director, Mark Wingfield is optimistic that the project heralds a new business line for the company: "This NATEP grant has given us and our partners the incentive and encouragement to turn a business proposition into a business reality, and we see good growth potential within the UAV market".

Contact: Tim Shires – timshires@amedm.co.uk

Ultrasonic Assisted Machining of Aerospace Composites (USAMAC)

Lead Partner

Kyocera Unimerco Tooling
Tooling development

Warwick Manufacturing Group
Testing and validation

Teer Coatings, Miba Coating Group
Coating development

BAE Systems
Customer

This project tackled the drilling of composite structures, in particular laminates of carbon reinforced composites and high performance titanium alloys, which are extremely challenging for tooling. Project leaders, Teer Coatings, together with tooling partner Kyocera Unimerco, teamed up with Warwick Manufacturing Group (WMG) to take advantage of WMG's expertise in a new innovation involving active tooling.

The benefits of Ultrasonic Assisted Drilling (UAD) in reducing cutting forces and tool wear rates, while preserving workpiece surface quality, are only just being recognised. Building on previous research and state of the art knowledge, the consortium combined advances in high performance multi-layer coatings, innovative drill design together with the latest in ultrasonically assisted machining technology, to improve drilling performance and extend drill life when machining composite/titanium alloy material stacks. Teer's R&D Manager, Hailin Sun, comments: "The unique combined expertise brought together under this NATEP partnership has allowed us to make significant advances in composite/titanium alloy drilling technology. Our collaboration continues as we explore this area further, and our end user, BAE Systems, remains very engaged and supportive".

Contact: Hailin Sun – hailin.sun@miba.com

Affordable Diffusion Bonding

Diffusion bonding is an established technology in the production of heat exchangers and fuel cells, but the equipment required is slow and expensive, and there are size limitations to assemblies that can be built. In this project, researchers at the University of Wolverhampton teamed up with induction heating specialists, Ajax Tocco, heat exchanger specialist H S Marston, and end users Unipart, Rolls-Royce Marine and BAE Systems. Research carried out at the University of Wolverhampton proved that it was possible to eliminate the large expensive pressure vessels, necessary in the conventional diffusion bonding process, and, by using local heating; good bonds could be achieved in less than a minute. With ATEP programme support the team developed a lower capital equipment cost process and a test rig demonstrator for the new bonding process.

Forging Tools using Nano Engineering (FORTUNE)

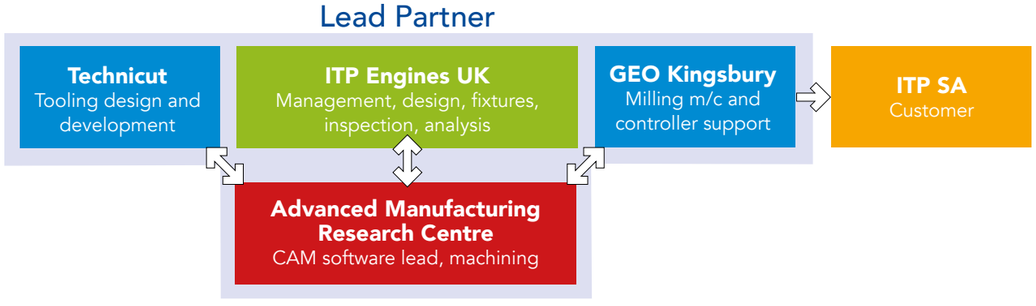
In the FORTUNE project, TCL, Anopol Limited and Birmingham University collaborated with Rolls-Royce Inchinnan, to investigate highly wear resistant multicomponent or multilayer hard coatings, based on CrN but incorporating other metals; these have been developed using closed field unbalanced magnetron sputter ion plating technology. They are exploited in coated machining and forming tools for a wide range of materials in various applications and environments. These coatings are characterized by desirable properties including good adhesion, high hardness, high toughness, high wear resistance, high thermal stability and high machining capability for steel. The coatings appear to show almost universal working characteristics under operating conditions of low and high temperature, low and high machining speed, machining of ordinary materials and difficult to machine materials, and machining under lubricated and under minimum lubricant quantity or even dry conditions. These coatings can be used for both cutting and forming tools, for conventional macro-machining tools as well as for micro-machining tools, either as a single coating or in combination with an advanced, self-lubricating topcoat.

Contact: Hailin Sun – hailin.sun@miba.com

Composite Actuation Gearbox Housing

The objective of the project led by Wolverhampton-based Goodrich Actuation Systems (now UTC Aerospace Systems) was to determine whether it would be possible to manufacture a viable, cost effective composite gearbox that would be interchangeable with a current aluminium die-casting gear box, but offering substantial weight savings. Secondary benefits over the aluminium housing were a lower thermal expansion when exposed to temperature extremes, and the elimination of corrosion. The composite unit manufactured by Rojac, which replicated the A320 Flap Line Gearbox, was endurance tested on a back-to-back gearbox test rig at Goodrich and met the design criteria. Moving from aluminium to a composite housing offered a 60% weight reduction.

Integrally Bladed Rotor (IBR) – Barrel Milling Cutter Development



This innovative NATEP project seeks to make improvements to a long-established manufacturing process for one particularly challenging group of engine components. The current manufacturing process for the blades on compressor Integrally Bladed Rotors (IBRs) typically completes milling of the blades in two operations, using a larger diameter tool for the aerofoil - thereby reducing the number of passes - and the smaller diameter tool for the fillet. Barrel milling cutters have a 'dual profile', theoretically allowing both operations to be performed with a single tool, hence saving machining time. There is also the added benefit of eliminating any machining 'mismatch' which can arise from a two tool approach. Whilst this type of tool is not new, its application to IBRs has not previously been successful, principally because the available CAM software does not adequately support this type of movement.

For this project, IBR manufacturer and project leader ITP Engines UK joined forces with cutting tool manufacturer Technicut, and milling machine supplier Geo Kingsbury. Working closely with the University of Sheffield Advanced Manufacturing Research Centre and leading CAM software vendors, the partners have been able to demonstrate a viable solution to IBR milling using a barrel cutter. Although there are still some hurdles to overcome, ITP's Engineering Director, Dan Price, is optimistic. "We are constantly looking for faster, more efficient ways to make engine parts; this NATEP project has enabled us to bring together the right team of experts and trial something which we have been considering for some time, with encouraging results".

Contact: Kevin Ngoe – kevin.ngoe@itpaero.com

Software Defined Telemetry

Lead Partner

G2 Communications
Wireless technology

TBG Solutions
System design, build, test

Rolls-Royce
Customer

This NATEP project tackled the challenge of reliably extracting instrumentation data from the rotating core during gas turbine engine testing. Currently, engine manufacturers such as Rolls-Royce make significant use of wireless radio data transmission systems (telemetry), but the harsh test environment makes reliable data collection very difficult; time-consuming set-up times, data drop-outs and signal corruption are relatively common issues, leading to the need to repeat tests. Existing hardware also has a limited bandwidth constraining the number of channels which can be simultaneously transmitted.

In this 18 month project, TBG Solutions has teamed up with G2 Communications to develop an innovative intelligent wireless telemetry system based on Software Defined Radio (SDR). By using SDR it has been possible to design a self-optimising system which operates over a range of radio frequencies to provide a highly reliability data transmission link, whilst minimising the power requirements from the on-board battery. TBG's Neil Roddis is optimistic about the possibilities for the system: "Although this project targeted the engine test cell application, there are many other potential applications outside of the aerospace sector where reliable and efficient wireless communications are needed for sensor networks."

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Surface Cooler Development

Advanced Chemical Etching
Etched components

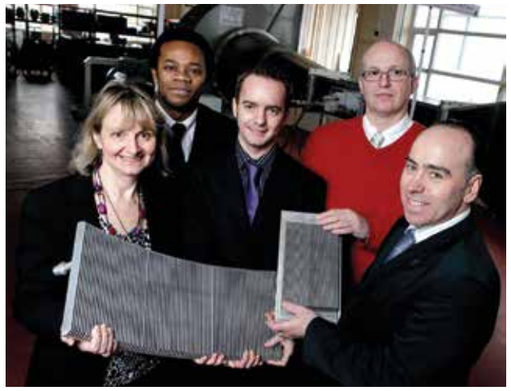
University of Wolverhampton
CFD modelling

Lead Partner

H S Marston
Design and test

Rolls-Royce Plc
Customer

This 2 year project with end user Rolls-Royce was led by H S Marston Aerospace and involved partners University of Wolverhampton and Advanced Chemical Etching (ACE). The aim of the project was to develop advanced surface coolers, a technology of particular interest to turbo fan jet engine manufacturers that was not currently available in the UK. The project centred around the use of a chemical etching process to produce single layer, open fin structures to facilitate oil cooling within the engine by-pass duct. This technique was designed to give a competitive advantage for the UK. Testing was carried out on a segment of a by-pass duct subjected to high air flow rates, and the results were used validate CFD models of different surface cooler configurations.



A2OX Aluminium Alloy

London & Scandinavian Metallurgical Co
Alloy melters

Grainger & Worrall
Precision sand casting

University of Birmingham
Modelling

Lead Partner

Aeromet International
Investment casting

Aero Engine Controls
Customer

This project built upon the success of a previous collaborative research project at the University of Birmingham, which resulted in a patented formulation of an innovative aluminium alloy called A2OX. Aeromet International, experts in investment casting, and Grainger & Worrall, experts in precision sand casting, worked together using materials produced by London & Scandinavian Metals to scale up the previous work.

This new material offered end user Aero Engine Controls (now Rolls-Royce) a step change in fatigue strength for its engine components. The University of Birmingham modelled the casting process which contributed to additional benefits including higher casting yields, with reduced processing time and energy usage. The picture shows a successfully produced complex fuel pump housing in the new material.

Aircraft Tyres Finite Element Modelling

Lead Partner

University of Birmingham
Modelling

Dunlop Aircraft Tyres
Tyre design

Airbus
Customer

This project was born out of a need by Dunlop Aircraft Tyres (DAT) to be able to accurately model new designs of aircraft radial tyres. Working closely with the University of Birmingham and Airbus, DAT developed a finite element modelling capability for tyres such that the behaviour and performance of new tyre designs could be predicted. The work programme evaluated current tools used in automotive tyre design and developed a process to integrate CAD and FE packages together with a tyre material database. Results from the modelling were validated against test data and were provided to Airbus in a format which fed directly into their landing gear system simulation.

Aerospring Spring Characterisation

Reliable Spring Manufacturing Co
Spring manufacture

Alloy Wire International
Materials supply

Institute of Spring Technology
Testing

Lead Partner

G&O Springs
Spring manufacture

BAE Systems
Customer

Goodrich Technical Centre
Customer

Redditch-based G&O Springs were aware that there was little if any empirical test data for springs manufactured from special aerospace alloys such as Inconel 718 or titanium. In the absence of information such as cycle life, relaxation over time and load at temperature, designs tended inevitably to be very conservative, with large design margins resulting in larger spring housings. G&O were confident that providing this missing data could lead to significant mass savings. In this 2 year project led by G&O Springs, they were joined by fellow spring manufacturer, Reliable Spring Manufacturing who produced a number of springs using a range of materials supplied by Alloy Wire International, for testing by the Institute of Spring Technology (IST). Tests included fatigue data, relaxation data and load-deflection curves over a range of temperatures. The results were incorporated into IST spring design programmes,

thereby allowing end users such as BAE Systems and Goodrich to develop smaller lighter aerospace components. G&O springs led design workshops for engineers from their customers and established themselves as knowledgeable suppliers.

Biocomposites for Aerospace Interiors

AIM Altitude
Component manufacture and test

Composites Evolution
Product management

Lead Partner

NetComposites
Prepreg development, project management

AIM Cabin Interiors
Customer

When lightweight fibre-reinforced polymer composite materials are used in fire-sensitive applications such as aircraft interiors, the most common state of the art solution is to use phenolic resin systems. However, during manufacture these materials pose some health risks to operators which need careful management, and moulded parts need extra operations to achieve a good surface finish.

In this NATEP project, NetComposites teamed up with AIM Altitude and Composites Evolution to develop a pre-impregnated (prepreg) composite material using a 100% bio-based polyfurfuryl alcohol (PFA) resin system. Compared to phenolic resins, PFA resins offer significant advantages; they are non-toxic, free of volatile organic compounds, and sustainably-derived from waste agricultural biomass. Furthermore, PFA resins provide these benefits without any compromises in terms of basic mechanical performance, fire performance or cost compared to phenolics. They also provide opportunities for improved out-of-mould surface finish.

Joe Carruthers, Managing Director of NetComposites sees a bright future for this new greener material: "The fire resistance tests in particular for PFA-based material exceeded all expectations. This may allow reinforcements to be used which up to now have not been considered feasible for aircraft interiors such as flax, perhaps paving the way for a 100% bio-composite material."

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Endurance Braking

James Kent
Ceramic Materials

CERAM
Chemistry and Testing

Lead Partner

Meggitt Aircraft Braking Systems
Manufacture

BAE Systems
Customer

Embraer
Customer

The objective of this project led by Meggitt Aircraft Braking Systems was to develop a braking system with a modular design, enabling it to be refurbished in modules, thus providing increased reliability and improved service life. The improvements came from the formulation of the carbon material with specially designed ceramic material developed by James Kent, an SME working in the dental industry mostly. The work involved incorporating and testing a number of new brake design

mechanical features to make it a modular design. A large number of materials were tested within the project as well as the modular design. An improved brake performance and longevity was achieved. Together with partners James Kent Ceramic Materials and CERAM (now Lucideon), the project team also developed advanced anti-oxidant coatings providing greater resistance to the agents that cause catalytic oxidation damage to existing brakes from runway de-icer fluids.

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Integrally Bladed Rotor (IBR) – Abrasive Flow Machining

ITP's blisk manufacturing centre of excellence in Lincoln, together with partners Extrude Hone and Brunel University, have been getting to grips with the science behind a 50 year old process that is used extensively after the machining of metallic parts to improve surface finish. This 2 year NATEP project has turned the spotlight on abrasive flow machining. Despite being deceptively simple in concept, the process has always been largely empirical because the underlying physics and chemistry are extremely complex and not fully understood.

During the project Brunel University has constructed a mathematical model of the abrasive flow machining process using the COMSOL Multiphysics® modelling software and the team have validated this through a series of tests on material coupons and blisk segments carried out by Extrude Hone and ITP. These tests have allowed researchers at Brunel to refine their model to a point where excellent agreement between predicted and actual wear rates and profiles has been achieved.

Whilst modelling has allowed ITP engineers to optimise the abrasive flow finishing of some parts, they have bigger goals in mind, and the key to success is predictability. ITP's Engineering Director, Dan Price, is enthusiastic about the new possibilities: "Being able to predict accurately exactly how much material will be removed, and where from, means that ITP are coming to see abrasive flow machining not so much a finishing process as a machining process. The new thinking is to leave more stock on blisk aerofoils during milling, and then bring parts to size using abrasive flow machining. This will lead to a reduction in 5-axis milling time."

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midlands aerospace alliance

The MAA is one of five regional aerospace alliances in the UK and is one of the biggest in the world with more than 300 member organisations, more than half of which make 'flying parts' which go onto the aircraft while the rest make equipment for design, testing, manufacturing or supply other specialist services.

Major Midlands aerospace companies including Meggitt, Moog Aircraft Group, Rolls-Royce and UTC Aerospace Systems sit on the MAA Board of Directors as do representative supply chain companies and regional partners.

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