UK Aerospace Research & Technology Programme

Project Directory

May 2018

AEROSPACE TECHNOLOGY INSTITUTE

INTRODUCTION

This directory provides a snap-shot of the UK Aerospace Research and Technology Programme which is defined by the UK's Aerospace Technology Strategy, *Raising Ambition*. This programme is delivered as a collaboration between the ATI, the Department for Business, Energy & Industrial Strategy (BEIS), and Innovate UK. It showcases the breadth and depth of activity enabled by the long-term commitment of government, and the efforts of the ATI and industry to shape compelling and important projects.

When *Raising Ambition* was published in 2016 £1.2 billion was on contract; since then a further £700m has been committed to research focusing on future high-value civil aerospace markets. Ambitions have escalated too. Major programmes in next generation wings and engines have developed with pace in the face of stiff market pressures and challenges. The ATI explicitly set out to encourage project development in "Smart, Connected and More Electric Aircraft", and it is reassuring to see this activity grow from 12% to 17% of the programme budget over the last 2 years. These developments are testament to the resolve of the UK aerospace industry to retain technological leadership.

In the last year, the ATI, BEIS and Innovate UK implemented a new project application process designed to reduce contracting timescales and enhance decision making that will improve the competitiveness of the programme. Linked to this, SMEs are benefitting exclusively from the NATEP programme which has received additional Aerospace Research and Technology investments. The ATI is closely involved in the governance of the NATEP programme, ensuring strategic alignment to *Raising Ambition*.

Disruption is becoming a bigger feature in our work, including radical electrical propulsion systems, aircraft designs that unlock new markets and capabilities to support transformational business models. These themes will further shape the project portfolio going forward, addressing technologies highlighted by *Raising Ambition* in the "Position" (i.e. 15+ years) timeframe. It also means that we need to remain agile and continue to evaluate priorities, while being focused and objective in developing our understanding against a backdrop of hype and excitement. We look forward to continuing our work with the sector in pursuit of this.

James McMicking
Chief Strategy Officer

FUNDING OPPORTUNITIES

First and foremost, the UK Aerospace Research and Technology Programme is open to any UK company or collaboration that meets the funding requirements and fits the scope of the UK Aerospace Technology Strategy.

Recognising the diversity of organisations that need to engage in research and technology development, the ATI has worked with partners Department for Business, Energy and Industrial Strategy (BEIS) and Innovate UK to offer several routes into the programme, including:

1. **SRC:** Four annual competitive funding batches overseen by the Strategic Review Committee (the SRC is an ATI and BEIS decision making and advisory panel for the entire UK Aerospace R&T Programme). Applicants can submit Expressions of Interest via Government's online Innovation Funding System (IFS) for consideration by the ATI in monthly reviews. Success provides the opportunity to develop a full application for assessment by the SRC and Innovate UK. The approach is best suited to large multi-million-pound strategic projects that require detailed assessment and scrutiny.
2. **CR&D:** Open theme-based competitive R&D (CR&D) funding competitions are developed on a case-by-case basis by the ATI and approved by the SRC to address specific priority technologies or incentivise collaboration. These opportunities involve a lighter-touch assessment process run between ATI and Innovate UK, targeting smaller projects with grant funding typically around £500k.
3. **NATEP:** The National Aerospace Technology Exploitation Programme (NATEP) is presently funded by the UK Aerospace R&T Programme. The ATI is a member of each of NATEP's regional advisory panels and chairs the NATEP national steering board. Limited to a maximum £150k grant for projects, with regular calls for proposals and a lighter-touch selection process, NATEP is ideally suited to small businesses looking to boost their technology agenda before potentially embarking on more ambitious programmes in the future.

CONTENTS

AEROSTRUCTURES OF THE FUTURE

This theme encompasses a range of aircraft structures and components provided by UK businesses, specifically the technologies, tools, processes and facilities needed to develop and produce them.

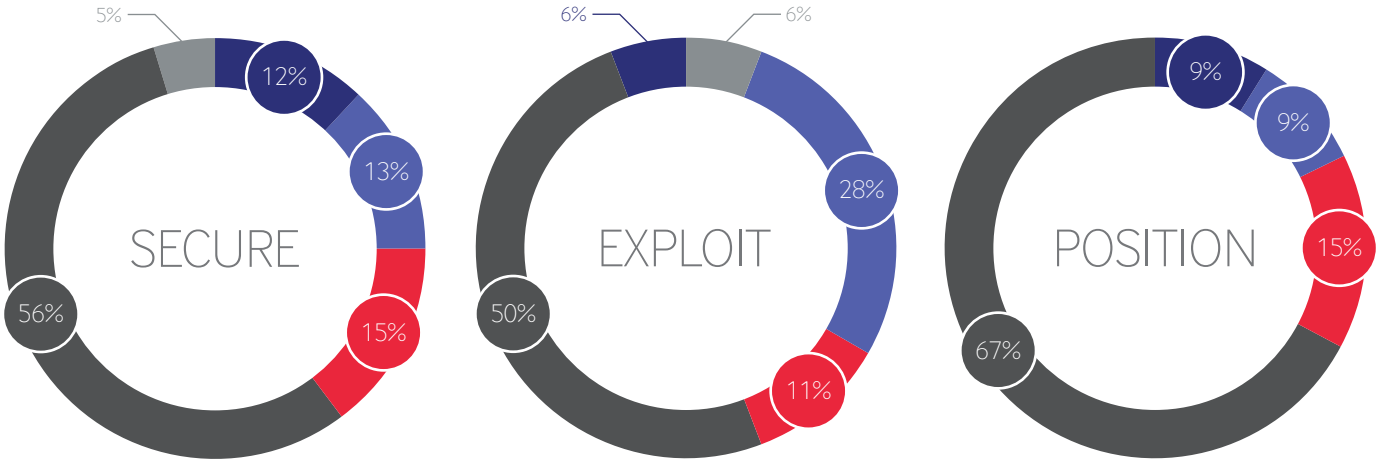
Development and manufacture of aerostructures constitutes around 25% of the sector's direct economic activity, concentrated in wide- and narrow-body passenger aircraft. The UK is a world leader in the design, manufacture and integration of wings and also provides components and sub-assemblies for nacelles, empennages and fuselages.

To deliver efficiency improvements, future wings will need improved aerodynamics, lighter materials and disruptive architectures, and incorporate more efficient propulsion systems. The cost and time required to design and produce wings must reduce to meet competitive pressure and achieve higher production rates. This will be achieved through more integrated composite architectures, using out-of-autoclave resin curing and automated manufacturing and assembly. Optimisation through Additive Manufacture will deliver lighter components. New manufacturing approaches will enable faster product transition, rate flexibility and customisation.

The Aerostructures of the Future theme in summary is:

- Strengthening the UK's position as a centre for large composite structures
- Raising levels of automation across manufacturing and assembly

Safety	Fuel Efficiency	Environment	Cost	Operational Needs & Flexibility	Passenger Experience	Totals
£44.63m	£121.54m	£66.65m	£287.84m	£27.51m	–	£548.17m

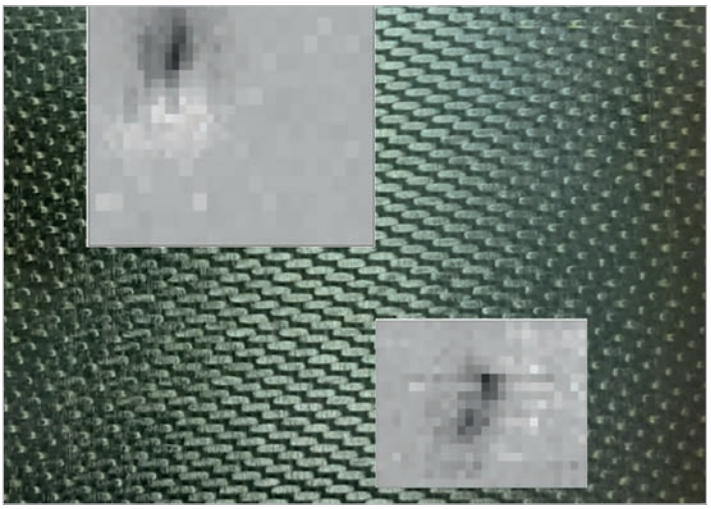


101799 – TiFab	
Project Title: Innovative Linear Friction Welding technology for Near Net Shape manufacture of advanced Ti aerospace components	
Value Stream: Aerostructures of the Future	
Time Horizon: Secure	**No. of Partners:** 4
Lead Partner: CAV Advanced Technologies	
All Partners: CAV Advanced Technologies, KUKA Systems, TEN Solutions, TWI	
Start date: 1/6/14	**End Date:** 31/5/17
Attributes: Environment, Cost	
Grant: £1.62m	**Total Cost:** £2.49m
Topic: Manufacturing Processes	

The TiFab project set out to develop Linear Friction Welding (LFW) technology as a new way of manufacturing aerospace quality components using near net shape titanium alloy, but with greater flexibility and higher production rates than are currently available. The TiFab project progressed the technology required for cost-effective LFW of titanium aero structures and developed this concept, culminating in the production and testing of an industrial demonstrator.

The project started in 2014 and completed successfully 3 years later with the manufacture of the industrial demonstrator. The project achieved a 100% success rate for LFW, promoting the key benefits of improved buy-to-fly ratios and reduced cost of manufacture. The work carried out within the TiFab project has allowed the partners to highlight the technology to OEMs and will differentiate the UK from low-cost overseas suppliers, safeguarding UK jobs. The outcomes of the project are expected to save over 200 tonnes of raw materials and £8.9m per year. Alan Shilton of TEN Solutions said, "The successful conclusion of this programme presents the aircraft industry with a viable and practical solution for reducing the cost of structural aircraft parts, with the potential to be a game changer in the field of Additive Manufacture."

101804 – CAN	
Project Title: Composite Aircraft NDE	
Value Stream: Aerostructures of the Future	
Time Horizon: Exploit	**No. of Partners:** 6
Lead Partner: QinetiQ	
All Partners: QinetiQ, Axi-tek, Rolls-Royce, University College London, University of Southampton, XTek	
Start date: 1/6/14	**End Date:** 31/8/17
Attributes: Environment	
Grant: £1.78m	**Total Cost:** £2.57m
Topic: Through-life	



Project CAN is developing new inspection techniques that will ensure modern aircraft can take full advantage of the benefits offered by using the latest materials and construction techniques, reducing the environmental impact and operating cost, while ensuring safe operation.

Two technologies, X-ray back scatter and Laminar CT, have been developed and demonstrated for the testing of aircraft structures, components and engines. The project offers both easily-interpreted high-quality images and the ability to inspect with the aircraft in service, 'at the gate'. The project has focused on carbon composite structures, but the inspection techniques can also be deployed for metallic components and are especially useful for hollow box sections and mixed materials.

Detecting BVID (barely visible impact damage) is a problem that has caused airframe manufacturers to increase the allowances in their designs. Project CAN technologies improve defect detection at both manufacture and in service, reducing the need for over engineering and reducing material usage. The project has ensured the practical applicability of the non-destructive evaluation technologies by using representative aircraft pieces. The test covers representative geometric features, as well as lightning strike protection and aircraft paint systems, including titanium-based white paint.

102367 – AMROCCS	
Project Title: Aircraft Maintenance Repair & Overhaul Configuration Capture System	
Value Stream: Aerostructures of the Future	
Time Horizon: Exploit	**No. of Partners:** 7
Lead Partner: Advanced Aerospace Assembly	
All Partners: Advanced Aerospace Assembly, Advanced Manufacturing Research Centre, Argenta-Europ, Intoware, NCTECH, QA, Serious Games International	
Start date: 1/10/15	**End Date:** 31/3/18
Attributes: Cost, Operational Needs & Flexibility	
Grant: £0.64m	**Total Cost:** £1.16m
Topic: Through-life	

Advanced Aerospace Assembly is leading a collaboration of SMEs to integrate many visualisation and scanning technologies aimed at reducing time and costs related to the maintenance of in-service aircraft. The outcome is a digitalised system to guide engineers through repair and maintenance; the MRO technician will be able to consult expert engineers, receive structured work instructions and take delivery of exactly the parts and tools required.

This could allow local trained engineers to perform the tasks, reducing the need for specialists to be transported to the aircraft location. "One low cost carrier quoted us that a delay of two hours can incur costs of around £5,000 in meal vouchers alone," said Mike Drummond, Commercial Manager of Argenta Europ, one of the partners. "The ability to perform these tasks quickly and efficiently can save a significant amount of unwanted expenditure". The project aims to have delivery of a TRL 5-6 demonstrator by 2018. The project is playing a key role speeding up development times for the participating SMEs and bringing the product to market quicker.

110136 – HVM-Casting-1	
Project Title: Large Scale Titanium Casting Facility	
Value Stream: Aerostructures of the Future	
Time Horizon: Secure	**No. of Partners:** 1
Lead Partner: Advanced Manufacturing Research Centre	
All Partners: Advanced Manufacturing Research Centre	
Start date: 1/1/14	**End Date:** 31/12/16
Attributes: Environment, Cost	
Grant: £7.16m	**Total Cost:** £7.16m
Topic: Manufacturing Processes	

AMRC Castings' new furnace is part of major investment that will enable the UK to compete on a global scale, producing some of the biggest titanium aerospace castings in the world. The new furnace will be capable of pouring 1000kg of titanium, the amount required to make a 500kg casting, and has three interchangeable crucibles. Titanium is very valuable in the aerospace industry, and is used in a variety of aircraft engine and structures components. Titanium is 30% stronger than steel and nearly 50% lighter. Compared to aluminium, it is twice as strong and has excellent strength retention to over 500°C.

In addition to the benefit for the aerospace industry, there is also significant value for other industries. This has already been demonstrated in the nuclear sector, delivering significant cost reductions. Several leading UK businesses have already expressed their interests in utilising the titanium castings capability in the near future. Previously, the United States dominated this market and was the only country capable of producing such large castings. However, the investment at the AMRC will enable the UK to compete globally, building on the organisation's extensive expertise in manufacturing smaller titanium castings.

110138 – HVM-AM	
Project Title: National Centre For Net Shape And Additive Manufacturing	
Value Stream: Aerostructures of the Future	
Time Horizon: Exploit	**No. of Partners:** 1
Lead Partner: Manufacturing Technology Centre	
All Partners: Manufacturing Technology Centre	
Start date: 1/12/13	**End Date:** 31/3/14
Attributes: Environment, Cost	
Grant: £4.19m	**Total Cost:** £4.19m
Topic: Additive Manufacture	

The National Centre for Net Shape and Additive Manufacturing, housed within the existing MTC facility, demonstrates the entire additive manufacturing (AM) process chain at an industrially relevant scale – taking raw material and part designs to produce fully-finished parts, where every stage of the process is carefully monitored and controlled. With expertise across all stages of the AM process the centre provides pragmatic and unbiased support to UK organisations interested in AM. Support follows a three-phase approach: discovery (explanation of AM and selection of appropriate process); demonstration (redesign, production and validation of demonstrator part); and pre-production (transition from demonstrator to full-scale production).

The Centre has delivered over 100 projects for companies across the supply chain: OEMs, Tier 1 suppliers and SMEs – including assisting SMEs with no previous experience of the aerospace sector to develop novel AM processing equipment, creating significant new market opportunities for them. Future work will aim to industrialise physical AM processes, and demonstrate how an effective digital twin can have a significant impact on the speed of delivery of the technology across a wide range of industries.

113036 – HORIZON	
Project Title: HORIZON (Additive Manufacture)	
Value Stream: Aerostructures of the Future	
Time Horizon: Exploit	**No. of Partners:** 6
Lead Partner: GKN Aerospace	
All Partners: GKN Aerospace, Advanced Manufacturing Research Centre, Autodesk, Delcam, Renishaw, Warwick Manufacturing Group	
Start date: 1/3/14	**End Date:** 31/5/18
Attributes: Cost	
Grant: £7.04m	**Total Cost:** £13.30m
Topic: Additive Manufacture	

The Horizon (AM) project aims to develop additive manufacturing (AM) techniques into viable production processes for aerospace parts and components. It is a diverse programme, covering metallic and polymer AM technologies, and has produced test demonstrators of three key AM technologies. The project team also collaborated with other ATI-supported projects and GKN sites to produce flight test hardware for the next-generation ice-protection systems developed in the WIST and ALFET projects.

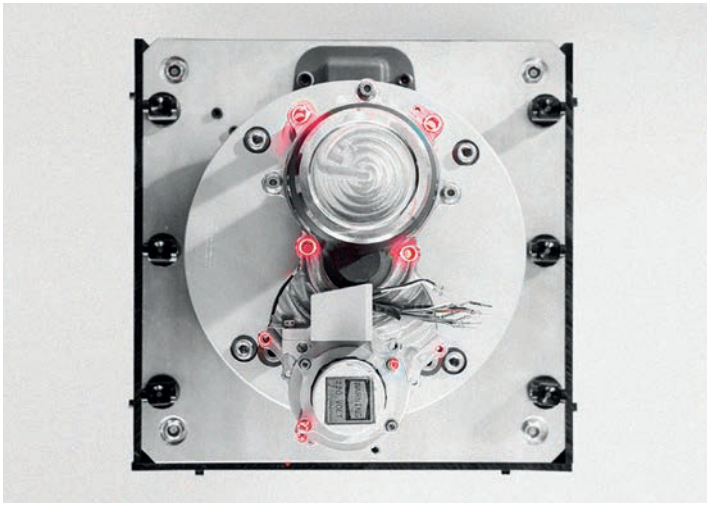
Horizon (AM) has secured the employment of 20 highly-skilled engineers, scientists and support staff ensuring that the UK workforce is developing the skills to compete in a cutting-edge area of technology. The ability of AM to deliver a component with a quick turnaround was key for this project – enabling GKN to provide rapid delivery to a customer and leading to further work. Dr Rob Sharman, Global Head of Additive Manufacturing at GKN, said, "It was all about the timing. We had a window of opportunity in which to fly a demonstrator on the research aircraft, and that window was very short. AM had a lead-time advantage compared to the other processes, and we were able to get the final part in a way that traditional manufacturing technology just couldn't."

113039 – AFoF	
Project Title: Aerostructures Factory of the Future	
Value Stream: Aerostructures of the Future	
Time Horizon: Exploit	**No. of Partners:** 3
Lead Partner: Spirit AeroSystems	
All Partners: Spirit AeroSystems, Advanced Manufacturing Research Centre, Aeromet International	
Start date: 1/1/15	**End Date:** 31/3/17
Attributes: Safety, Environment, Cost	
Grant: £2.42m	**Total Cost:** £3.52m
Topic: Manufacturing Processes	

The Aerostructures Factory of the Future (AFoF) project was designed to improve manufacturing process technology to increase production efficiency; to develop, test and validate complex manufacturing processes for aircraft wing manufacture; and to bring aerospace component work packages back to the UK. The work packages were aligned to both protect current capability and win new business. The collective objective was to strengthen Spirit's industrialised path in the manufacture of high-rate aerostructures for new variants of current aircraft and next-generation platforms. While the main product focus was Fixed Leading Edge (FLE), the technologies developed can be utilised to support future work on other structures, including tail-planes and winglets.

The AFoF project has been highly successful in reducing manufacturing cost and process times by up to 20% for single-aisle products and proving key technologies to TRL6. The production flow simulation in particular was integral to the on-shoring of A320 spoiler production, new factory investment and additional employment. Scott McLarty, Vice President and General Manager of Spirit UK and Malaysia, said, "We are pleased that this innovative technology development brings not only improved quality and savings to our customer, but also secures an additional work stream for the UK business."

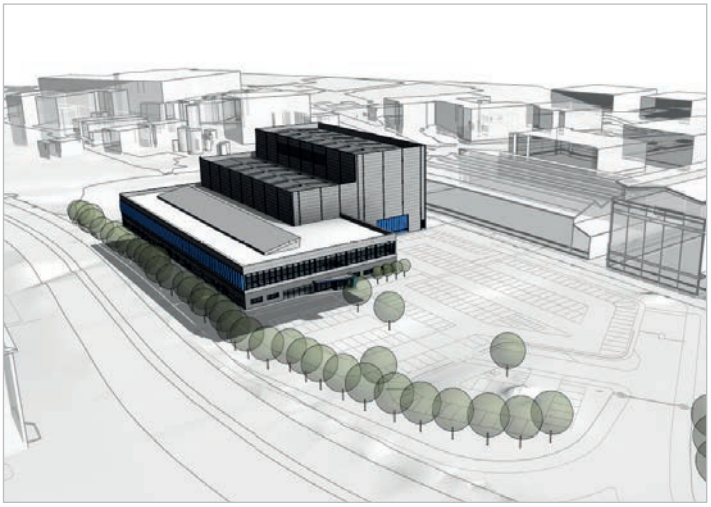
113055 – M4	
Project Title: Meggitt Modular Modifiable Manufacturing	
Value Stream: Aerostructures of the Future	
Time Horizon: Position	**No. of Partners:** 4
Lead Partner: Meggitt Aerospace	
All Partners: Meggitt Aerospace, Advanced Manufacturing Research Centre, IBM, Manufacturing Technology Centre	
Start date: 1/7/15	**End Date:** 31/3/19
Attributes: Cost	
Grant: £2.49m	**Total Cost:** £4.99m
Topic: Smart Systems	



Meggitt is working in collaboration with the Advanced Manufacturing Research Centre (AMRC), the Manufacturing Technology Centre (MTC), Cranfield University and IBM UK. This project aims to overcome the challenges associated with diverse, highly-complex product offerings supplied to the aerospace sector. The work programme will challenge current value stream conventions by capitalising on the integration of digital tools to enable multi-component work flows. It targets improving productivity and operational excellence – through dynamic scheduling, generating simulations and data analytics to predict capacity requirements and performance, visibility and traceability of components.

Shop floor operators will be supported through fully-adaptable intelligent work benches, autonomous intelligent vehicles to provide 'smart box' sub-assemblies and component parts, digital work instructions and smart tools including laser projected guides to minimise error, control traceability and minimise unnecessary waste during the production processes. Meggitt aims to demonstrate the integration of 3 or more diverse product value streams into one, increasing both operator knowledge and capability and maximising utilisation of assets. Meggitt believes this development will yield a significant increase in productivity when applied across product lines.

113064 – AWIC	
Project Title: Airbus Wing Integration Centre	
Value Stream: Aerostructures of the Future	
Time Horizon: Exploit	**No. of Partners:** 1
Lead Partner: Airbus Operations	
All Partners: Airbus Operations	
Start date: 12/1/15	**End Date:** 28/2/19
Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility	
Grant: £13.45m	**Total Cost:** £26.90m
Topic: Infrastructure	



The Airbus Wing Integration Centre (AWIC) will be a flagship open-access facility for all future UK work on wing and associated systems, for Airbus UK and strategic technology partners (Tier 1 suppliers, SMEs and research organisations). AWIC is integral to the creation of a streamlined wing engineering value chain, enabling rapid and cost-effective development. The facility will be 10,255m² and will house approximately 250 engineers. The facility will enable flexible laboratory and workshop space for secure IP development, and collaborative working; the elimination of non-integrated ways of working, reducing time and cost for TRL progression; the development of future technologies and designs with manufacturing, reducing risk; and structural test rigs with flexible configuration to reduce cost and lead times.

"The UK is globally recognised for its expertise in wing design and development and AWIC represents a significant investment in state-of-the-art facilities that will be at the heart of developing the next generation of aircraft", said Mark Howard, Head of R&T Business Development and Partnerships at Airbus UK. AWIC will also be used to train Airbus and suppliers' personnel, graduates and apprentices in the latest technologies, and will support around 1,000 UK jobs in the UK Ground Based Demonstrator Programme.

113104 – ZIP	
Project Title: Zephyr Innovation Programme	
Value Stream: Aerostructures of the Future	
Time Horizon: Exploit	**No. of Partners:** 6
Lead Partner: Airbus Defence & Space	
All Partners: Airbus Defence & Space, Cranfield University, Formtech Composites, Newcastle University, Oxis Energy, Productiv	
Start date: 1/11/16	**End Date:** 31/1/19
Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility	
Grant: £3.64m	**Total Cost:** £7.42m
Topic: More electric aircraft	

Zephyr Innovation Programme' (ZIP) aligns with the ATI's 'More Electric Aircraft' and 'Aerostructures' Technology Themes by developing the UK's supply chain to meet a clear market opportunity. The world-record breaking, unmanned, solar-electric, stratospheric aircraft, Zephyr, was developed as a High Altitude Pseudo Satellite (HAPS) flying at up to 70kft, carrying payloads that provide services (e.g. surveillance) to the defence sector. Airbus is developing the next generation of Zephyr to address the substantially larger civilian markets in remote sensing (£3.2bn) and internet connectivity (£14bn).

This requires flight performance improvements to expand operations to higher latitudes all year-round, cost reduction and design for higher volume manufacturing. ZIP will develop key technologies in aerostructures, energy storage and propulsion to address these challenges ahead of international competition and strengthen the UK supply chain in time for World Radiocommunication Conference 2020. This 27 month and £7.61m (£3.64m grant) project partners UK SMEs and academics with project lead, Airbus, as the primary route to market, aiming for a capability of up to 500 aircraft p.a. by 2020, creating 72 skilled jobs with growth potential for 2,500.

101800 – AutoDISC

Project Title: Automated ultrasonic inspection of aerospace composites with enhanced defect detection probabilities aided by gantry deployed, CAD controlled robotics

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 6

Lead Partner: Plant Integrity

All Partners: Plant Integrity, Brunel University, Innovative Technology and Science, JackWeld, Kingston Computer Consultancy, Net Composites

Description: AutoDISC proposed two key non-destructive inspection innovations that increased automation and made the current inspection process quicker, more efficient and more accurate. Gantry deployed, CAD controlled robotics will provide 100% coverage and secondly a step increase in detection probability for composite defects, implemented through an inference engine performing similarity analysis.

Start date: 1/8/14 | **End Date:** 31/7/17

Attributes: Safety, Cost, Operational Needs & Flexibility

Grant: £1.40m | **Total Cost:** £2.01m

Topic: Through-life

101803 – InHeatPro

Project Title: Highly efficient induction heating process to cure and health monitor the bonding of composite patches on aircraft structures

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 5

Lead Partner: Stirling Dynamics

All Partners: Stirling Dynamics, Argon Design, Hitex, McWade Associates, TWI

Description: InHeatPro developed a 'smart-patch' system with a reliable, low cost, integrated sensor network that acts as part of a feedback control system for active cure control. Sensors are also used as active transducer elements enabling non-destructive inspection of the patch to detect voids and disbonds that are equal to or larger than the critical size.

Start date: 1/7/14 | **End Date:** 31/7/17

Attributes: Safety, Cost, Operational Needs & Flexibility

Grant: £0.94m | **Total Cost:** £1.29m

Topic: Through-life

102362 – HTAP-AM

Project Title: High temperature, affordable polymer composites for AM aerospace applications

Value Stream: Aerostructures of the Future

Time Horizon: Position | **No. of Partners:** 9

Lead Partner: VICTREX Manufacturing

All Partners: VICTREX Manufacturing, 3T RPD, Airbus Group, Avon Valley Precision Engineering, E3D-Online, EOS Electro Optical Systems, HiETA Technologies, South West Metal Finishing, University of Exeter

Description: HTAP-AM is investigating the technical barriers hindering Additive Manufacture (AM) of High performance mouldable plastics in the polyaryletherketone family (PAEK). The project aims to further the exploitation of AM-PAEK, making the process more reliable, cost effective and a common place fabrication route for future aerostructures throughout the supply chain.

Start date: 1/2/16 | **End Date:** 31/7/18

Attributes: Cost

Grant: £0.81m | **Total Cost:** £1.62m

Topic: Additive Manufacture

102368 – BAM

Project Title: Breakthrough Aerospace Material

Value Stream: Aerostructures of the Future

Time Horizon: Position | **No. of Partners:** 13

Lead Partner: Sigmatex

All Partners: Sigmatex, Antich & Sons, BAE Systems, ESI, M Wright & Sons, Meggitt Aerospace, MSC Software, National Composites Centre, QinetiQ, Rolls-Royce, Teledyne, University of Manchester, University of Nottingham

Description: BAM investigates the use of 3D woven composite material for application to aircraft structures and neighbouring sectors such as automotive. The benefits include lower weight structures and reduced manufacturing and assembly costs. Aspects of overall process from design to manufacture of 3D woven composite fabric components were enhanced in this programme.

Start date: 1/3/16 | **End Date:** 28/2/19

Attributes: Cost

Grant: £1.79m | **Total Cost:** £3.58m

Topic: Additive Manufacture

102373 – STAD-MRO

Project Title: Surface Tolerances for Aircraft Design, Maintenance and Repair

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: IHS Global

All Partners: IHS Global, University of Leeds, Virtualpie

Description: STAD-MRO is developing and validating rapid CFD-based tools that capture the effects of manufacturing tolerance at joints, surface roughness/waviness and gaps on lift and pitching moment over a wide range of surface shapes and flow conditions. These methods enable designers to trade surface finish requirements between performance benefits and manufacturing costs reducing total ownership costs.

Start date: 1/3/16 | **End Date:** 31/8/18

Attributes: Cost, Operational Needs & Flexibility

Grant: £0.47m | **Total Cost:** £0.93m

Topic: Through-life

102375 – SHAPE

Project Title: Self-Healing Alloys for Precsion Engineering

Value Stream: Aerostructures of the Future

Time Horizon: Position | **No. of Partners:** 3

Lead Partner: Ilika Technologies

All Partners: Ilika Technologies, Advanced Manufacturing Research Centre, Reliance Precision

Description: SHAPE has two aims: firstly, to develop a new generation of self-healing alloys suitable for Additive Manufacturing (AM) processes and secondly; to develop a metallic manufacturing process that takes advantages of the flexibility and environmental credentials offered by AM and the precision offered by subtractive manufacturing.

Start date: 1/9/15 | **End Date:** 28/2/19

Attributes: Environment, Cost

Grant: £1.07m | **Total Cost:** £2.13m

Topic: Through-life

102376 – RiviT

Project Title: RiviT

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Plant Integrity

All Partners: Plant Integrity, Air Salvage International, Innovative Technology and Science, Morgan-Ward

Description: RiviT combines MRO and NDT specialists to provide a cost-effective solution for the onset of crack propagation at difficult to access doubler repaired aircraft panels. It uses a niche ultrasonic technique to qualitatively give a rapid indication whether a previously repaired aircraft panel has become defective or not without disassembly of the entire airframe.

Start date: 1/12/15 | **End Date:** 31/5/18

Attributes: Safety, Cost, Operational Needs & Flexibility

Grant: £0.47m | **Total Cost:** £0.94m

Topic: Through-life

110050 – Airstream

Project Title: Airstream

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 6

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, BAE Systems, Cranfield University, QinetiQ, The Open University

Description: The objective of AIRSTREAM is to advance the development of generic technologies enabling further optimised structural engineering and manufacturing processes to be exploited on future Airbus aircraft. These technologies are the future 'building blocks' of knowledge used in component design, manufacture and assembly, from concept validation through to final production.

Start date: 1/1/09 | **End Date:** 31/3/14

Attributes: Safety, Cost

Grant: £4.89m | **Total Cost:** £9.78m

Topic: Wing of Tomorrow

110051 – ALCAS

Project Title: Advanced Low-Cost Aircraft Structures

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Bombardier Aerospace

Description: ALCAS brought together the key UK players in wing construction technologies. The project covered measurement and assembly techniques for key wing components, as well as curing processes, optimised tooling and improved NDT techniques for composite materials, processing and components; with the design and manufacturing of test panels to validate performance.

Start date: 1/1/09 | **End Date:** 30/9/10

Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £1.23m | **Total Cost:** £2.46m

Topic: Manufacturing Processes

110052 – APART

Project Title: Advanced Power-plant and Aerodynamic Research Technologies

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group

Description: APART provided initial investigations to inform several longer-term research projects for the Smart Active Wing of the Future project. The technologies developed formed key components of the future 'building blocks' of knowledge within the UK, to be used in conceptual design, modelling, testing, manufacture and assembly of future aircraft wings.

Start date: 1/1/09 | **End Date:** 31/12/09

Attributes: Safety, Cost

Grant: £1.63m | **Total Cost:** £3.26m

Topic: Wing of Tomorrow

110054 – RATE

Project Title: RATE

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Airbus Operations

All Partners: Airbus Operations, GE Aviation Systems, GKN Aerospace, Spirit AeroSystems

Description: The target weight reductions from RATE improves the performance and reduces the volume of carbon dioxide/oxides of nitrogen per passenger. The technologies from RATE also enables the consortium to reduce non recurring costs, provide early product maturity and numerous continuing product development opportunities on other Airbus products.

Start date: 1/10/10 | **End Date:** 31/3/13

Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £7.41m | **Total Cost:** £14.82m

Topic: Wing of Tomorrow

110055 – Smart Active Wing

Project Title: Smart Active Wing of the Future

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, Aircraft Research Association, QinetiQ, Stirling Dynamics

Description: The overall aim of the SAWoF (Smart Active Wing of the Future) campaign is to establish a full understanding of a flow controlled wing. Key issues include flow control technologies, impacts to performance and engineering and manufacturing challenges to a practical implementation of the technology.

Start date: 1/1/10 | **End Date:** 31/3/14

Attributes: Fuel Efficiency

Grant: £5.72m | **Total Cost:** £11.34m

Topic: Multi-physics, Multi-fidelity Modelling

110108 – HV Composites

Project Title: High Value Composites

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, National Composites Centre

Description: The Composite Structures Development Centre at Airbus UK, focused on the technological development of large wing structures, including low-cost, high volume technologies for the wider structural applications of composite materials. Further advances in composite design and technology are likely to increase the composites content on the next generation narrow body aircraft.

Start date: 1/10/11 | **End Date:** 31/3/12

Attributes: Safety, Fuel Efficiency, Environment, Cost

Grant: £0.80m | **Total Cost:** £1.50m

Topic: Wing of Tomorrow

110111 – SteM

Project Title: Structures Technology Maturity

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: GKN Aerospace

All Partners: GKN Aerospace, Bombardier Aerospace, GE Aviation Systems, Spirit AeroSystems

Description: The STeM programme of work brings together a consortium of Primes and leading supply chain companies to support new concepts in wing design that push the boundaries of aerodynamic performance. The project targeted developing high rate, high value manufacturing capability for efficient airframe structures through advanced automation and assembly technologies.

Start date: 1/4/12 | **End Date:** 30/4/14

Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £6.12m | **Total Cost:** £12.25m

Topic: Manufacturing Processes

110114 – AIWO

Project Title: Advanced Integrated Wing Optimisation

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 6

Lead Partner: Airbus Operations

All Partners: Airbus Operations, GE Aviation Systems, GKN Aerospace, Tyco Electronics, Ultra Electronics Holdings, Goodrich Actuation Systems

Description: The aim of 'AIWO' is to secure a robust set of innovative technologies, at the integrated wing-level, for the next all-new Airbus product. This will be achieved by taking the key outcomes from recent UK funded collaborative programmes and to further expand the potential of the technologies identified.

Start date: 1/1/12 | **End Date:** 30/9/14

Attributes: Cost

Grant: £9.62m | **Total Cost:** £19.24m

Topic: Wing of Tomorrow

110125 – Wing Box

Project Title: Innovative Wing Box

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Spirit AeroSystems

Description: 'InBox' Innovative Wing-Box secures a robust set of integrated innovative technologies for wing-box, driven by the latest requirements for aero configuration and shape for the next all-new Airbus product. This has been achieved by taking the key outcomes from recent UK funded collaborative programmes to explore potential future technologies.

Start date: 1/4/12 | **End Date:** 31/3/14

Attributes: Fuel Efficiency, Cost

Grant: £4.19m | **Total Cost:** £8.38m

Topic: Wing of Tomorrow

110126 – FIRST

Project Title: Fuel & Inserting Research for Systems Technologies

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Eaton Aerospace

Description: FIRST provides large scale rig testing ability and aims to improve testing capability within the UK both at Airbus Filton site and at other UK based testing facilities. Work within FIRST has led to upgrades of test rigs to perform fuel systems testing under simulated flight conditions.

Start date: 1/1/12 | **End Date:** 31/3/14

Attributes: Cost

Grant: £1.53m | **Total Cost:** £3.07m

Topic: Wing of Tomorrow

110135 – HVM-Aero

Project Title: MTC Aerospace Centre

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Manufacturing Technology Centre

All Partners: Manufacturing Technology Centre

Description: This £15m project undertaken by the MTC established a National Aerospace Research Centre, which would enable leading edge aerospace research and projects between MTC engineers and the aerospace industry. The Centre, which opened in 2015, is developing innovations in areas such as improved assembly technologies, sensors and data analytics.

Start date: 1/1/14 | **End Date:** 31/3/15

Attributes: Environment, Cost

Grant: £15.04m | **Total Cost:** £15.04m

Topic: Infrastructure

110137 – HVM-Casting-2

Project Title: Mega-Shell Large Scale Ceramic Shell Investment Casting Facility

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Advanced Manufacturing Research Centre

All Partners: Advanced Manufacturing Research Centre

Description: Through this capital project, the AMRC Castings group have developed a ceramic shell moulding and casting capability for very large precision castings. By investing in this capability, AMRC Castings will now be able to produce parts in moulds suitable for the largest aero engine intercases and structural aerospace components.

Start date: 1/12/13 | **End Date:** 30/9/17

Attributes: Environment, Cost

Grant: £8.26m | **Total Cost:** £8.26m

Topic: Manufacturing Processes

113024 – EFT

Project Title: Enhanced Fidelity Transonic Wing

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 8

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, Aircraft Research Association, CFMS, City University, Cranfield University, National Composites Centre, University of Liverpool

Description: EFT uses theoretical methods for aerodynamic loads prediction throughout the aircraft envelope to enable higher levels of structural and design optimisation. The objective is to significantly enhance the performance assessment fidelity of transonic wings, reducing risk and uncertainty in the aircraft design process and enabling aircraft to be driven to higher performance standards.

Start date: 1/1/14 | **End Date:** 31/3/18

Attributes: Fuel Efficiency

Grant: £7.30m | **Total Cost:** £11.51m

Topic: Wing of Tomorrow

113025 – WIST

Project Title: Wing Integrated Systems Technologies

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 6

Lead Partner: Airbus Operations

All Partners: Airbus Operations, GE Aviation Systems, GKN Aerospace, National Composites Centre, Tyco Electronics, Ultra Electronics Holdings

Description: WIST focusses on the development of novel systems architectures, equipment and installation component technologies to support high volume and low cost composite wing manufacture, assembly and equipping. WIST includes a number of critical wing technology streams including Fuel Systems, Ice Protection and Electrical and Optical Networks.

Start date: 1/4/14 | **End Date:** 31/12/17

Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £8.29m | **Total Cost:** £14.54m

Topic: Wing of Tomorrow

113026 – WILETE

Project Title: Wing Integrated Leading Edge and Trailing Edge

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Airbus Operations

All Partners: Airbus Operations, National Composites Centre, Spirit AeroSystems

Description: WILETE will focusses on the development of leading and trailing edge structure component and assembly technologies to support high volume and low cost composite wing manufacture, assembly and equipping. WILETE develops wing leading edge and trailing edge structures and integration of electrical systems including ice protection and flight controls.

Start date: 1/4/14 | **End Date:** 30/9/17

Attributes: Safety, Fuel Efficiency, Environment, Cost

Grant: £4.46m | **Total Cost:** £6.87m

Topic: Wing of Tomorrow

113027 – WDMA

Project Title: Wing Design, Manufacture and Assembly

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Airbus Operations

All Partners: Airbus Operations, National Composites Centre, Spirit AeroSystems

Description: WDMA focuses on the development of wing-box structural concept and build solutions which are able to satisfy the requirements for very high production-rates and low costs. These are essential to meet the business requirements for future products. WDMA develops design optimisation and innovative manufacturing processes for a future wing configuration.

Start date: 1/4/14 | **End Date:** 30/9/17

Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £8.65m | **Total Cost:** £13.13m

Topic: Wing of Tomorrow

113028 – CI

Project Title: Wing Concept Integration

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Airbus Operations

All Partners: Airbus Operations, National Composites Centre, Spirit AeroSystems, University of Manchester

Description: Concept Integration focusses on the industrialisation of technologies, development of disruptive solutions for future products and will be responsible for integration activities across the suite of Airbus Wing of the Tomorrow technologies. CI ensures that suites of integrated technologies are optimised and matched to the particular requirements of the aircraft application.

Start date: 1/4/14 | **End Date:** 30/6/17

Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £3.78m | **Total Cost:** £5.78m

Topic: Wing of Tomorrow

113037 – PROTEST

Project Title: PROTEction of STructures from Lightning Strike

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: Airbus Group

All Partners: Airbus Group, Airbus Operations, Cardiff University, Hexcel Composites, National Composites Centre

Description: The PROTEST project was run by Airbus Group Innovations, Hexcel, Cardiff University and the National Composites Centre to focus on developing toolsets for the next generation of lightning strike capable composite materials. It integrated test impact data with existing models into predictive tools available in the design process.

Start date: 1/4/14 | **End Date:** 31/12/18

Attributes: Safety, Environment, Cost, Operational Needs & Flexibility

Grant: £1.69m | **Total Cost:** £2.62m

Topic: Through-life

113040 – VIEWS

Project Title: Validation and Integration of Manufacturing Enablers for Future Wing Structures

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 13

Lead Partner: GKN Aerospace

All Partners: GKN Aerospace, Advanced Forming Research Centre, Advanced Manufacturing Research Centre, Bombardier Aerospace, GE Aviation Systems, Manufacturing Technology Centre, National Composites Centre, Sheffield Hallam University, Spirit AeroSystems, University of Bath, University of Exeter, University of Nottingham, Warwick Manufacturing Group

Description: The VIEWS project led by GKN Aerospace and industrial partners was aimed at reducing the cost of wing manufacture and assembly by 20% and process time by 80% by advancing wing design, manufacturing and assembly technologies near to market readiness, whilst selecting some novel technologies for further development.

Start date: 1/4/14 | **End Date:** 31/3/17

Attributes: Safety, Fuel Efficiency, Environment, Cost

Grant: £18.76m | **Total Cost:** £30.48m

Topic: Manufacturing Processes

113041 – AWI

Project Title: Agile Wing Integration

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 6

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, Cranfield University, Loughborough University, Marshalls, National Composites Centre

Description: This proposal is part of a wider set of Overall Aircraft Design projects which aims to position Airbus and its partners at the forefront of aircraft technological changes. this is done by developing rapid, world-beating Wing Design and Integration capability and solutions for use during the early phases of an aircraft product development cycle.

Start date: 1/7/14 | **End Date:** 30/9/18

Attributes: Cost

Grant: £8.52m | **Total Cost:** £16.98m

Topic: Wing of Tomorrow

113044 – StEP

Project Title: Step-change in Efficient Production

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Airbus Operations

All Partners: Airbus Operations

Description: This project delivers a 'step-change' capability to wing production in Broughton by helping the plant increase its rates of production in parallel to improving cost performance. Fundamentally, this ensures the Airbus Broughton plant is well positioned to cope with the future demands for production rate increases.

Start date: 1/5/14 | **End Date:** 31/10/17

Attributes: Cost

Grant: £7.95m | **Total Cost:** £15.89m

Topic: Manufacturing Processes

113045 – FotF-AWMA

Project Title: Factory of the Future for Aircraft Wing Manufacture and Assembly

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 13

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Advanced Manufacturing Research Centre, Aertec Solutions, Airbus Group, BAE Systems, Bombardier Aerospace, Cranfield University, Datum Tool Design, Eventmap, Hexagon Metrology, Manufacturing Technology Centre, Queen's University Belfast, Seco Tools

Description: This project enables component manufacture, assembly and equipping to be developed and proven in a safe environment, before being applied to the production line. The project improves industrial performance, through the development of optimised methods, processes and tools – boosting productivity by up to 30% and leading to cost reductions.

Start date: 1/4/14 | **End Date:** 30/6/17

Attributes: Fuel Efficiency, Environment, Cost

Grant: £8.79m | **Total Cost:** £13.46m

Topic: Manufacturing Processes

113047 – BLADE-UK

Project Title: Development and qualification of a structural concept for a large transport aircraft low drag, natural laminar flow wing for large scale flight testing

Value Stream: Aerostructures of the Future

Time Horizon: Position | **No. of Partners:** 1

Lead Partner: Airbus Operations

All Partners: Airbus Operations

Description: The BLADE-UK project is Airbus in the UK's contribution to designing, developing, manufacturing and assembling a completely new 10 metre laminar section of wing and assemble this to an A340 flight test aircraft. Research focusses on structural design including manufacturing, assembly and testing of critical components of the wing.

Start date: 1/4/14 | **End Date:** 31/12/17

Attributes: Safety, Fuel Efficiency, Environment, Cost

Grant: £3.60m | **Total Cost:** £7.20m

Topic: Multi-physics, Multi-fidelity Modelling

113048 – StEAM

Project Title: Structural Enablers for Advanced Metallic Wing

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, CFMS, Constellium, Magellan Aerospace

Description: The Structural Enablers for Advanced Metallic Wing project is a collaboration between industry and research organisation. The project is investigating technologies for both the short term and long term exploitation in advanced metallic wings. These include bi-metallic welded components, bonded metallic components, near-net shape fabrication of components and assembly technologies.

Start date: 1/7/14 | **End Date:** 30/6/17

Attributes: Safety, Environment, Cost, Operational Needs & Flexibility

Grant: £2.95m | **Total Cost:** £5.79m

Topic: Wing of Tomorrow

113051 – TiPOW

Project Title: Titanium Powder for Net-shape Component Manufacture

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: GKN Aerospace

All Partners: GKN Aerospace, Metalysis, Phoenix Scientific Industries, University of Leeds

Description: TiPOW is an initiative by a consortium of leading UK companies proposing to define the requirements and develop the processing techniques to provide high quality Titanium powder; enabling the production of aerospace components via 3D printing or Additive Manufacturing (AM) for future complex lightweight aircraft and aero-engine parts.

Start date: 1/3/15 | **End Date:** 28/2/19

Attributes: Safety, Fuel Efficiency, Environment, Cost

Grant: £1.51m | **Total Cost:** £3.03m

Topic: Additive Manufacture

113062 – EBM

Project Title: Operational Development Cell for Electron Beam Melting

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: GKN Aerospace

All Partners: GKN Aerospace

Description: This project established an Additive Manufacture Electron Beam Melting (EBM) cell at the GKN Aerospace site in Filton, aimed at developing high value/high complexity lightweight aerospace components using a high-power electron beam to melt metal powder, layer by layer to build advanced aircraft and aero-engine components and products.

Start date: 1/4/15 | **End Date:** 31/3/18

Attributes: Safety, Fuel Efficiency, Environment, Cost

Grant: £1.85m | **Total Cost:** £3.70m

Topic: Additive Manufacture

113065 – DIJIT

Project Title: Development of Innovative Jigs and Tools

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Advanced Manufacturing Research Centre, University College London

Description: The Development of Innovative Jigs and Tools (DIJIT) project is an innovative and novel testing capability at Airbus in Filton. DIJIT offers the capability to carry out tests up to full scale wing sizes which will secure future work for the Structures Test department in Filton and will safeguard jobs.

Start date: 1/12/15 | **End Date:** 31/5/19

Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £5.61m | **Total Cost:** £11.22m

Topic: Manufacturing Processes

113079 – FRoMHAA

Project Title: Flexible Robotic Machining in High Accuracy Applications

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Advanced Manufacturing Research Centre

All Partners: Advanced Manufacturing Research Centre

Description: Through this project, the AMRC will aim to provide UK aerospace industry with a unique capability for high accuracy robotic machining to enable increased productivity, ramp-up production, and reduce the cost of manufacturing. The project will address specific robot limitations and enable more high-accuracy aerospace manufacturing tasks to be automated.

Start date: 1/6/16 | **End Date:** 31/5/17

Attributes: Cost, Operational Needs & Flexibility

Grant: £0.51m | **Total Cost:** £0.51m

Topic: Manufacturing Processes

113087 – CastFast

Project Title: CastFast

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Advanced Manufacturing Research Centre

All Partners: Advanced Manufacturing Research Centre

Description: New facilities at AMRC's Casting Centre will be used to develop technologies for UK foundries and tool manufacturers to enable world-class wing tooling and fast-make aerostructures and engine parts. The project will exploit benefits of additive manufacturing and sand and investment casting to produce low cost, high quality aerospace components.

Start date: 1/11/16 | **End Date:** 31/3/18

Attributes: Environment, Cost

Grant: £4.10m | **Total Cost:** £4.10m

Topic: Infrastructure

113100 – SCENIC

Project Title: Supply Chain ENablement for Increased Competitiveness

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Queen's University Belfast

All Partners: Queen's University Belfast

Description: This investment will establish a high-class open access manufacturing technology facility at NITC in Belfast, encouraging and enabling increased research and development by UK industry, with a particular focus on SMEs. OEMs will participate providing leadership and the market need, while technology providers will support projects providing latest technical know-how.

Start date: 1/10/16 | **End Date:** 31/3/18

Attributes: Cost

Grant: £4.99m | **Total Cost:** £4.99m

Topic: Infrastructure

113102 – DAITAS

Project Title: Developing Automated Assembly & Inspection Technologies for Aircraft Structures

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: GKN Aerospace

All Partners: GKN Aerospace, Bombardier Aerospace

Description: This initiative, led by GKN Aerospace, is aimed at advancing current technologies and knowledge in automated assembly and inspection for current and future aerospace platforms. Successful implementation of the technologies will help improve manufacturing productivity, build skills in automation and programming and enable improvements in rate capability, quality and cost.

Start date: 1/7/16 | **End Date:** 30/6/19

Attributes: Cost

Grant: £4.00m | **Total Cost:** £8.00m

Topic: Through-life

113111 – CoCoMAP

Project Title: Competitive Composite Manufacturing Processes

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Bombardier Aerospace

All Partners: Bombardier Aerospace

Description: CoCoMaP focuses on improving the competitiveness of composite manufacturing processes and metallic technologies. The project examines how increased production rates can be met through efficiencies in assembly, fabrication, tooling and optimising the Resin Transfer Infusion process. It is also looking at developing repair procedures and nearer net shape metallic solutions to achieve major cost reductions.

Start date: 1/8/16 | **End Date:** 31/10/18

Attributes: Fuel Efficiency, Environment, Cost

Grant: £1.84m | **Total Cost:** £3.69m

Topic: Manufacturing Processes

113131 – NATEP2

Project Title: National Aerospace Technology Exploitation Programme 2

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: ADS Group

All Partners: ADS Group

Description: The National Aerospace Technology Exploitation Programme (NATEP) is aimed at helping small and medium sized suppliers develop their own innovative aerospace technologies to enhance their capabilities and increase their ability to win new business with higher tier companies anywhere in the world, providing the UK with a prosperous supply chain.

Start date: 1/6/17 | **End Date:** 30/6/20

Attributes: Cost

Grant: £8.00m | **Total Cost:** £14.46m

Topic: Manufacturing Processes

113133 – PERFORM

Project Title: Disruptive Textile Technology for Aerospace Applications

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Advanced Manufacturing Research Centre

All Partners: Advanced Manufacturing Research Centre

Description: This project covers the acquisition of state-of-the-art equipment for composite preforming using disruptive textile technology, to be used by the AMRC Composites Centre and industrial partners. The equipment will also be used to develop novel solutions for joining, impregnation and process automation to enable cost reductions of complex composite components.

Start date: 1/9/17 | **End Date:** 31/8/18

Attributes: Cost

Grant: £3.28m | **Total Cost:** £3.28m

Topic: Manufacturing Processes

113134 – HiStruct

Project Title: High-rate, High-volume Technologies for Large Aero-structures

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: National Composites Centre

All Partners: National Composites Centre

Description: This investment is focussed around the acquisition of advanced composites production technologies, supporting the manufacture of future aerostructures components, predominantly wing technologies. The project will establish advanced manufacturing pilot lines with deposition and infusion capability at the NCC to develop and validate suitable out-of-autoclave technologies for next generation aerospace products.

Start date: 1/6/17 | **End Date:** 30/11/19

Attributes: Cost

Grant: £9.97m | **Total Cost:** £9.97m

Topic: Manufacturing Processes

113135 – ICE

Project Title: Wing Innovative Components

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Airbus Operations

All Partners: Airbus Operations, GE Aviation Systems, GKN Aerospace, Spirit AeroSystems

Description: This project will deliver new dry fibre technologies for use in the Wing of Tomorrow primary structure components. It develops several key full scale components to the Wing of Tomorrow Demonstrators including Leading and Trailing Edges, Ribs and Spars, and it delivers the means by which to test one of the 3 full scale Wing demonstrators.

Start date: 1/4/17 | **End Date:** 31/3 /21

Attributes: Fuel Efficiency, Cost

Grant: £9.66m | **Total Cost:** £19.33m

Topic: Wing of Tomorrow

113136 – HyEnd

Project Title: Wing Hybrid Enablers for Product Development

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Constellium, GE Aviation Systems, GKN Aerospace

Description: This project will develop technologies, architecture and deliver major components (CFRP and metallic) into the Wing of Tomorrow demonstrators. This will provide new methods and design rules for CFRP wing structure, and components to support the validation of wing assembly and equipping capability. The scope is a combination of methods, technology development and component manufacturing.

Start date: 1/4/17 | **End Date:** 31/3/21

Attributes: Fuel Efficiency, Cost

Grant: £9.30m | **Total Cost:** £18.61m

Topic: Wing of Tomorrow

113137 – HighBox

Project Title: Wing High Rate Box

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, GKN Aerospace

Description: This project will develop and deliver major components into the Wing of the Tomorrow demonstrators. The scope is technology development, large scale manufacturing capability preparation, and large scale component manufacturing (integrated top-cover/front spar), in a representative industrial environment. This validation is essential to mitigate the key risks involved when ramping-up actual Carbon Fibre Reinforced Plastic (CFRP) production components.

Start date: 1/4/17 | **End Date:** 31/3/21

Attributes: Fuel Efficiency, Cost

Grant: £7.81m | **Total Cost:** £15.62m

Topic: Wing of Tomorrow

113138 – IFED

Project Title: Wing Innovative Feeder Demonstrators

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Spirit AeroSystems

Description: This project will provide data for physical validation of innovative Carbon Fibre Reinforced Plastic (CFRP) wing structure for high-performance/high-production rate wing for candidate technologies. The scope is coupon and sub-scale manufacturing development trials, leading into manufacturing and assembly of a sub-scale wingbox. This will support and de-risk major wingbox manufacture, assembly and testing for Wing of Tomorrow.

Start date: 1/4/17 | **End Date:** 31/3/21

Attributes: Fuel Efficiency, Cost

Grant: £8.69m | **Total Cost:** £17.39m

Topic: Wing of Tomorrow

113139 – WIRED

Project Title: Wing Integrated Assembly Demonstrator

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Spirit AeroSystems

Description: This project will provide physical validation at full-scale of high-rate Carbon Fibre Reinforced Plastic (CFRP) wing assembly and equipping for Wing of Tomorrow. The scope is full wing component assembly, systems equipping and test in a representative industrial environment. This validation is essential to mitigate the key risks when ramping-up actual production at high-rate for innovative major integrated CFRP components.

Start date: 1/4/17 | **End Date:** 31/3/21

Attributes: Fuel Efficiency, Cost

Grant: £9.43m | **Total Cost:** £18.86m

Topic: Manufacturing Processes

113141 – Gear & Actuation

Project Title: Gear and Actuation Systems Manufacturing

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Advanced Manufacturing Research Centre

All Partners: Advanced Manufacturing Research Centre, Boeing

Description: Boeing, in collaboration with the AMRC, are developing manufacturing equipment to be used in the recently announced Boeing UK manufacturing facility for gear and actuator components. This will involve evaluation of new machining and casting technologies in a highly automated demonstration facility, which will manufacture actuator systems for commercial aircraft.

Start date: 1/9/17 | **End Date:** 31/8/20

Attributes: Cost

Grant: £2.70m | **Total Cost:** £5.60m

Topic: Manufacturing Processes

113147 – MAXIM

Project Title: Multi AXial Infusion Materials

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Hexcel Composites

All Partners: Hexcel Composites

Description: This project will develop progressive, cost-effective materials and manufacturing solutions for large aerospace and automotive composite structures. Hexcel is investing in expanding its Leicester plant by installing state-of-the art machines for carbon non-crimp fabrics development and laboratory equipment for research into this technology, in partnership with the National Composites Centre.

Start date: 1/6/17 | **End Date:** 31/5/21

Attributes: Fuel Efficiency, Cost

Grant: £3.76m | **Total Cost:** £7.53m

Topic: Manufacturing Processes

113148 – CO-MET

Project Title: COmposite and METallic Developments

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: GKN Aerospace

All Partners: GKN Aerospace

Description: CO-MET is a technology development programme aimed at advancing current technologies and knowledge in composite and metallic processing for current product and advanced structures for application on future new aircraft platforms. The programme is critical for the intermediate future operations given the potential gains in productivity-efficiency-repeatability and quality are compelling.

Start date: 1/5/17 | **End Date:** 30/4/20

Attributes: Cost

Grant: £4.85m | **Total Cost:** £9.70m

Topic: Manufacturing Processes

113162 – Wing LIFT

Project Title: Wing Lean Innovative Future Technology

Value Stream: Aerostructures of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Luebbering, Spirit AeroSystems, University of Nottingham

Description: The project provides essential technical building blocks to enable industrialisation of the Wing of Tomorrow programme, at a ramp up to rate 60 or more per month, in a cost effective way. This will be achieved through the development of key technologies in the areas of Automated Wing Assembly, Inspection and Equipping for Hybrid Aluminium/Carbon/Titanium product.

Start date: 1/7/17 | **End Date:** 30/6/20

Attributes: Cost

Grant: £8.25m | **Total Cost:** £16.50m

Topic: Manufacturing Processes

113163 – FA3D2

Project Title: Future Automated Aircraft Assembly Demonstrator 2

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: University of Nottingham

All Partners: University of Nottingham

Description: FA3D2 will deliver a national experimental testbed and technology demonstrator in digital and informatics enabled aerospace manufacturing technologies. It provides an opportunity for UK based aerospace manufacturing businesses to test, demonstrate and accelerate implementation of new breakthrough technologies to improve product quality and cost by implementing a flexible assembly approach.

Start date: 1/1/18 | **End Date:** 31/12/22

Attributes: Cost

Grant: £3.80m | **Total Cost:** £3.80m

Topic: Manufacturing Processes

113164 – OAAM

Project Title: Open Architecture Additive Manufacturing

Value Stream: Aerostructures of the Future

Time Horizon: Exploit | **No. of Partners:** 10

Lead Partner: TWI

All Partners: TWI, Advanced Forming Research Centre, Airbus Group, Airbus Operations, Autodesk, Cranfield University, Glenalmond Group, Isotek, University of Bath, University of Manchester

Description: OAAM develops 3 directed energy deposition additive manufacturing technologies - arc-wire, electron beam and laser-powder - that can be scaled up to accept multi-metre component sizes. The systems and state-of-the-art research facilities establish a fully quantifiable process and offer access to a simplified, lower risk route to support AM's industrialisation and deployment into aircraft platforms.

Start date: 1/1/18 | **End Date:** 31/12/20

Attributes: Fuel Efficiency, Cost

Grant: £6.59m | **Total Cost:** £8.47m

Topic: Additive Manufacture


A350
XWB

AIRCRAFT OF THE FUTURE

This theme incorporates the design, integration, certification and operation of aircraft and their interaction with the broader air transport system.

The UK performs whole-aircraft design integration within the civil helicopter and defence segments, and provides leading capabilities through universities, independent research organisations and consultancy. The activity constitutes around 10% of the UK aerospace sector's direct economic activity, however the capabilities involved help to secure the sector more broadly.

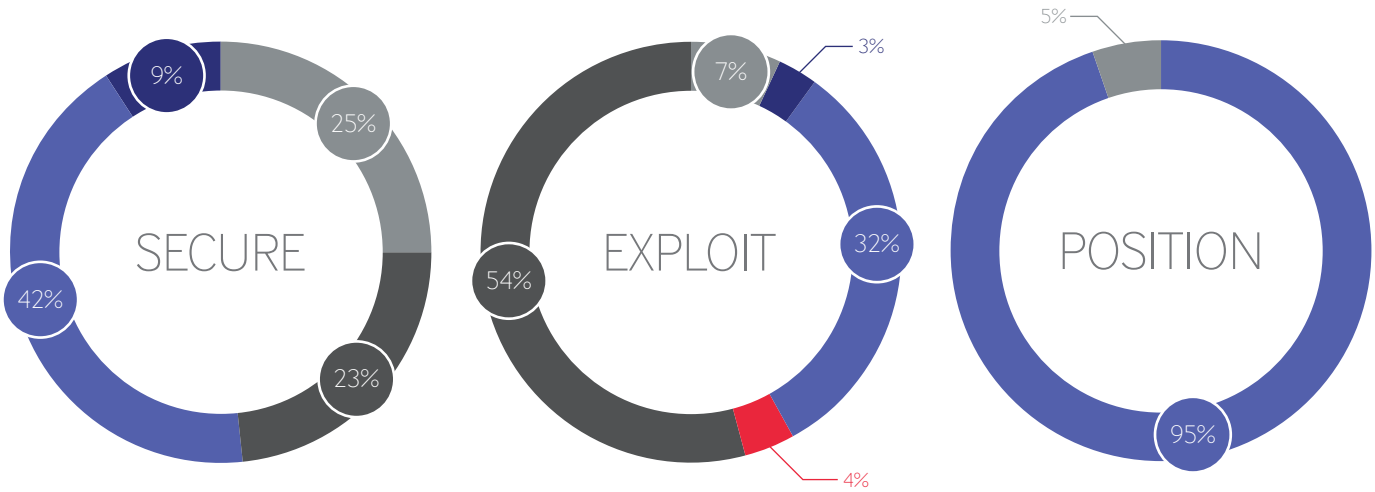
Major aircraft subsystems designed and manufactured in the UK are shaped by whole aircraft design and integration. Aerodynamics, through simulation and test, determines the geometry of an aircraft and drives its structural and control needs. These capabilities are therefore important to the UK's position in the global civil aerospace industry and underpin the UK's involvement in more radical aircraft architectures beyond 2030.

The global growth of aviation is driving the need for improved fuel efficiency through optimised flight trajectories, improved safety and security, and accommodation of autonomous systems. The Institute is working with other UK organisations and internationally to develop strategies and technology needs that help to position the UK at the forefront of air transport system development.

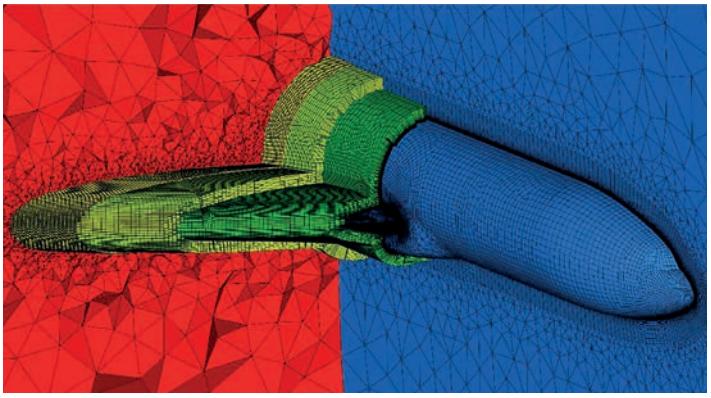
The Aircraft of the Future theme in summary is:

- Strengthening whole-aircraft design and system integration capability
- Understanding the potential of more radical aircraft architectures and the impact of technologies at whole aircraft level.
- Accelerating development of enhanced safety, and more productive and autonomous aircraft

Safety	Fuel Efficiency	Environment	Cost	Operational Needs & Flexibility	Passenger Experience	Totals
£6.04m	£66.41m	£3.85m	£58.50m	£16.14m	–	£150.94m



101372 – GHandI	
Project Title: Geometry Handling and Integration	
Value Stream: Aircraft of the Future	
Time Horizon: Exploit	**No. of Partners:** 7
Lead Partner: MBDA	
All Partners: Airbus Operations , Aircraft Research Association , Altran, BAE Systems , International Technegroup, MBDA, Rolls-Royce	
Start date: 1/3/13	**End Date:** 31/12/15
Attributes: Cost	
Grant: £2.47m	**Total Cost:** £4.96m
Topic: Multi-physics, Multi-fidelity Modelling	

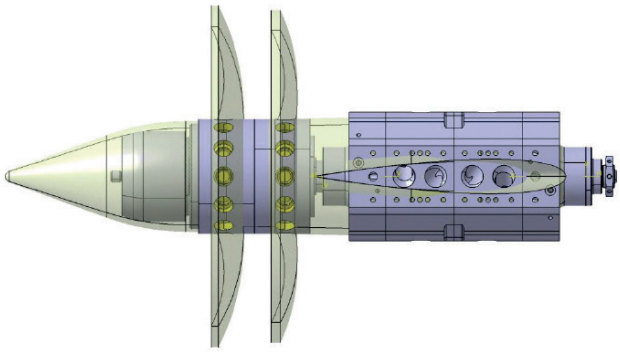


One of the fundamental properties affecting the aerodynamic performance of a body is its shape. With increasing demands for performance, the need to optimise novel airframe and turbomachinery shapes rapidly and with efficient processes is becoming increasingly important. For the first time, GHandI brought together the UK aerodynamics community to facilitate knowledge sharing and cross-fertilisation and to establish innovative capabilities.

The project set out to develop a shared assessment and wider awareness of current industrial requirements and practices; to develop improved industrial capabilities for geometry generation, manipulation and interrogation; to develop improved links to these geometry handling capabilities with industrial numerical simulation processes, in particular mesh generation; and to generate improved insight as to how these capabilities should be developed in the future to further competitive advantage. Depending on application, the effort to prepare geometry models for numerical analysis were reduced by 20-90% - reducing the time required from days/weeks to hours/minutes. For the quality and robustness of automated meshing techniques, some processes were fully-automated and others showed improvements of 30-80%.

Incorporating faster design process cycles into the product development lifecycle will enable the partners to offer better products faster and with increased confidence, leading to a greater market share.

110109 – ARA-R&D	
Project Title: Aircraft Research Association Research and Development	
Value Stream: Aircraft of the Future	
Time Horizon: Secure	**No. of Partners:** 1
Lead Partner: Aircraft Research Association	
All Partners: Aircraft Research Association	
Start date: 1/4/12	**End Date:** 31/3/14
Attributes: Fuel Efficiency	
Grant: £6.82m	**Total Cost:** £6.82m
Topic: Infrastructure	



The Aircraft Research Association identified areas of research that would allow them to develop leading capabilities and datasets that would be available for the wider UK industrial base. These areas of focus included the implementation of a gust rig in the tunnel, propulsion test development of powered models, research around hybrid laminar flow control (HLFC), and design of a cavity rig to simulate landing gear/weapons bay flow characteristics. As well as these core capabilities, the research activity has also generated significant new capabilities for ARA in a number of measurement techniques and tools, including Particle Image Velocimetry (PIV) flow visualisation, Constant Temperature Anemometry (CTA) turbulence measurement, Acoustic Beam Forming noise measurement from the model, and Pressure Sensitive Paint (PSP) flow measurement.

The dissemination of the projects has boosted the standing of ARA within the field, both at home and abroad. This has helped win work in European research projects, mostly within the Clean Sky and Clean Sky 2 Joint Technology Initiatives. The project was run on a large scale with 150 people involved. An additional benefit of the investment is that 60% of the funding has been spent outside of ARA in the UK supply chain, with over 100 different suppliers involved.

101367 – HARMONY

Project Title: wHole AiRcraft Multidisciplinary nOise desigN sYstem

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: Rolls-Royce

All Partners: Airbus Operations, Bombardier Aerospace, Rolls-Royce, University of Cambridge, University of Southampton

Description: HARMONY provides the UK industry with unsteady flow and aero acoustic prediction capabilities for the key airframe and propulsion noise sources associated with future concepts for entry into service in 2020 and beyond. This provides a step change in aero acoustic modelling capability validated by high fidelity measured data and facilitated by increased collaboration.

Start date: 1/2/13 | **End Date:** 31/7/16

Attributes: Environment

Grant: £1.84m | **Total Cost:** £3.59m

Topic: Multi-physics, Multi-fidelity Modelling

101370 – HiPerTilt

Project Title: Innovative Aerodynamic Design Solutions for High-Performance Tiltrotor Aircraft

Value Stream: Aircraft of the Future

Time Horizon: Position | **No. of Partners:** 4

Lead Partner: Leonardo Helicopters

All Partners: Leonardo Helicopters, National Composites Centre, University of Glasgow, University of Liverpool

Description: Tilt-rotorcraft offer the potential to revolutionise vertical lift passenger transport by delivering higher speeds, freeing up existing regional airport capacity. HiPerTilt developed world leading aerodynamic models, processes, techniques and new designs/products integral to the design and development of next generation tilt-rotorcraft in the UK, delivering a significant reduction in design time.

Start date: 1/4/13 | **End Date:** 31/3/17

Attributes: Fuel Efficiency, Operational Needs & Flexibility

Grant: £1.22m | **Total Cost:** £2.43m

Topic: Multi-physics, Multi-fidelity Modelling

101373 – CONGA

Project Title: Configuration Optimisation of Next Generation Aircraft

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 7

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, Aircraft Research Association, Cranfield University, Eurostep, MSC Software, Rolls-Royce

Description: This project develops a selection of innovative capabilities. By bringing together designers and methods developers, it is possible to demonstrate and evaluate the benefits gained from adoption of these enhanced capabilities for a range of potential aircraft architectures, making deployment more effective and paving the way for further future capability enhancement.

Start date: 1/2/13 | **End Date:** 31/3/15

Attributes: Cost

Grant: £4.19m | **Total Cost:** £8.34m

Topic: Multi-physics, Multi-fidelity Modelling

101798 – LOCATE

Project Title: LOw CArbon aircraft using lighter than air TEchnology

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 7

Lead Partner: Hybrid Air Vehicles

All Partners: Hybrid Air Vehicles, Advanced Manufacturing Research Centre, Blue Bear Systems Research, Cranfield University, Forward Composites, University of Glasgow, University of Liverpool

Description: LOCATE focused on lowering the developmental risks in key technology areas novel aircraft aerodynamics, carbon composite structures, avionics monitoring systems and improving rate production for the development of Hybrid Air Vehicles' capability in the field of hybrid aircraft and lighter-than-air technology. The project was successful in supporting enhancements to the Airlander 10.

Start date: 1/5/14 | **End Date:** 31/1/17

Attributes: Safety, Fuel Efficiency, Cost

Grant: £2.54m | **Total Cost:** £3.78m

Topic: Multi-physics, Multi-fidelity Modelling

102361 – AIRSTART

Project Title: Accelerated Integration of Reliable Small UAV systems Through Applied Research & Testing

Value Stream: Aircraft of the Future

Time Horizon: Secure | **No. of Partners:** 8

Lead Partner: Airbus Group

All Partners: Airbus Group, ARPAS-UK, Blue Bear Systems Research, Callen-Lenz Associates, Cranfield University, RNLI , Rotron Power, University of Southampton

Description: AIRSTART has led the charge for small commercial UAS, by addressing the lack of affordable, lightweight detect & avoid and fast & secure communications technology required for safe operation Beyond Visual Line of Sight, and increased endurance. Core technologies were validated through a series of small UAS flight trials led by end user operational scenarios.

Start date: 1/11/15 | **End Date:** 30/4/18

Attributes: Safety, Operational Needs & Flexibility

Grant: £1.60m | **Total Cost:** £3.14m

Topic: Unmanned Aerial Systems

102364 – AuGMENT

Project Title: Advanced Geometry and Meshing Engineering Tools

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Cambridge Flow Solutions

All Partners: Cambridge Flow Solutions, International Technegroup

Description: AuGMENT is developing advanced tools for geometry and meshing allowing engineering simulation to participate fully and effectively in the earliest stages of industrial design. Two complementary products, BoXeR and CADfix were successfully integrated into interoperable end-user products that combine their strengths, making it possible for users to access the benefits of both.

Start date: 1/8/15 | **End Date:** 31/7/18

Attributes: Fuel Efficiency, Cost

Grant: £0.65m | **Total Cost:** £1.30m

Topic: Multi-physics, Multi-fidelity Modelling

102366 – Hyper Flux ++

Project Title: Hyper Flux ++

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Zenotech

All Partners: Zenotech, Aircraft Research Association, Bombardier Aerospace, CFMS

Description: Hyper Flux ++ aims to further develop capability aerodynamic modelling of undercarriages and nacelles, with over 30,000 surfaces to be modelled by the software. It is estimated that time will be accelerated by 10x for the same fixed cost, significantly increasing design productivity and throughput. The design tools are applicable to a range of sectors, such as civil engineering, renewable energy, automotive.

Start date: 1/11/15 | **End Date:** 31/10/18

Attributes: Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £0.51m | **Total Cost:** £1.02m

Topic: Multi-physics, Multi-fidelity Modelling

102370 – ADAS20

Project Title: Airborne Detect and Avoid System 2020

Value Stream: Aircraft of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Barnard Microsystems

All Partners: Barnard Microsystems, OptoSignal, Tony Henley Consulting

Description: ADAS20 is developing a prototype collision detect and avoid system to enable Beyond-Line-Of-Sight (BLOS) operating capability for Remotely Piloted Aircraft systems (RPAS). The project is bringing together a consortium of SMEs and once proven on remotely piloted aircraft, this technology could also be used in light manned aircraft applications.

Start date: 1/8/15 | **End Date:** 31/7/18

Attributes: Safety, Operational Needs & Flexibility

Grant: £1.22m | **Total Cost:** £2.43m

Topic: Unmanned Aerial Systems

102377 – FES

Project Title: Future Engineering System

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 6

Lead Partner: CFMS

All Partners: CFMS , Advanced Manufacturing Research Centre, eQ Technologic, Rolls-Royce, Sysemia, University of Leeds

Description: The consortium is developing and demonstrating a prototype Future Engineering System infrastructure to integrate engineering data sources within the process lifecycle management tool chain. FES will demonstrate the integration of raw data from CFD and FEA analyses with uncertainty quantification and management (UQ&M) functions and automated agent-based quality control.

Start date: 1/4/16 | **End Date:** 31/3/19

Attributes: Cost

Grant: £2.11m | **Total Cost:** £4.25m

Topic: Infrastructure

102379 – Phoenix

Project Title: Phoenix Unmanned Air System

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 14

Lead Partner: CPI Innovation

All Partners: CPI Innovation , Advanced Manufacturing Research Centre, Athene Works, Blue Bear Systems Research, Bruce Banks Sails, IQE, Manufacturing Technology Centre, National Composites Centre, Newcastle University, Shadow Robot Company, Stirling Dynamics, TCS Micropumps, University of Southampton, University of the Highlands and Islands

Description: The Phoenix Unmanned Air System project is an industry led project to research into a novel method of 'clean' efficient propulsion for an unmanned air system with associated technologies to facilitate extended time-on-station and long endurance.

Start date: 1/3/16 | **End Date:** 28/2/19

Attributes: Fuel Efficiency

Grant: £1.69m | **Total Cost:** £3.29m

Topic: Unmanned Aerial Systems

102382 – EMPAS

Project Title: Electric Motor Powered Aero-engine Simulation of aircraft models in wind tunnels

Value Stream: Aircraft of the Future

Time Horizon: Secure | **No. of Partners:** 5

Lead Partner: QinetiQ

All Partners: QinetiQ, Aerodynamic Test Equipment, Boeing, Surrey University, Goodrich Control Systems

Description: EMPAS aims to further develop permanent magnet electric motors used in the F1 industry, which has the potential to provide the power density necessary for the effective simulation of scaled jet engines. The associated test control infrastructure, and techniques, for successful aerospace wind tunnel testing will also be advanced.

Start date: 1/6/16 | **End Date:** 31/8/19

Attributes: Fuel Efficiency

Grant: £1.19m | **Total Cost:** £2.42m

Topic: More Electric Aircraft

110053 – ANSD

Project Title: Airbus Numerical Simulation and Design

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Aircraft Research Association, Altran

Description: ANSD (Airbus Numerical Simulation and Design) addresses the need to develop specific simulation and design technologies fundamental to future capability to undertake aerodynamic and multidisciplinary (MD) design. It includes techniques to provide new technologies to the Airbus simulation toolset for exploitation on aircraft design.

Start date: 1/6/10 | **End Date:** 31/3/14

Attributes: Safety, Fuel Efficiency, Cost

Grant: £2.36m | **Total Cost:** £4.72m

Topic: Multi-physics, Multi-fidelity Modelling

110058 – NGVL P3

Project Title: Next Generation Vertical Lift Programme - Flight Trials

Value Stream: Aircraft of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Leonardo Helicopters

All Partners: Leonardo Helicopters, National Composites Centre

Description: Next Generation Vertical Lift project on Flight Trials investigated manufacturing of blade specimens for non-destructive and destructive structural testing and certifying rotor systems in event of bird/lightning strikes. The project also developed a toolkit for combining Scanning Laser Doppler Vibrometry with Finite Element Modelling used for validation of dynamic design for airframe structures.

Start date: 1/10/10 | **End Date:** 31/3/15

Attributes: Cost, Operational Needs & Flexibility

Grant: £2.50m | **Total Cost:** £10.85m

Topic: Infrastructure

110112 – ARA-Capital

Project Title: ARA Capital Equipment

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Aircraft Research Association

All Partners: Aircraft Research Association

Description: This project supported upgrades and modifications to the existing world class Transonic Wind Tunnel (TWT) facility at the Aircraft Research Association in Bedford. This included improvements to the tunnel control systems, more high-performance computing capacity for calculations and additional capability for workshop model manufacture to produce accurate and representative aircraft models.

Start date: 1/4/12 | **End Date:** 31/3/14

Attributes: Cost

Grant: £3.09m | **Total Cost:** £3.09m

Topic: Infrastructure

110113 – ExpAERO

Project Title: Experimental Aerodynamics

Value Stream: Aircraft of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Aircraft Research Association

Description: The ExpAERO project generates a deeper understanding of the flows on transonic wings in a number of specific areas where detailed experimental data is lacking. It provides the input to enhance Airbus wing design methods. The main project activities have been based in Bristol and Bedford.

Start date: 1/4/12 | **End Date:** 31/3/14

Attributes: Fuel Efficiency

Grant: £1.28m | **Total Cost:** £2.55m

Topic: Multi-physics, Multi-fidelity Modelling

110133 – ARA-Capital-2

Project Title: ARA Capital Equipment 2

Value Stream: Aircraft of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Aircraft Research Association

All Partners: Aircraft Research Association

Description: This project supported upgrades and modifications to the existing world class Transonic Wind Tunnel (TWT) facility at the Aircraft Research Association in Bedford. This included development of improved acoustic measurement equipment and the associated data acquisition systems. This supports the UK industry being able to deliver new more efficient aircraft concepts.

Start date: 1/8/13 | **End Date:** 31/3/15

Attributes: Cost

Grant: £2.11m | **Total Cost:** £2.11m

Topic: Infrastructure

113003 – ASTRAEA 3a

Project Title: ASTRAEA 3a – Regulatory Engagement

Value Stream: Aircraft of the Future

Time Horizon: Secure | **No. of Partners:** 7

Lead Partner: BAE Systems

All Partners: BAE Systems, Airbus Defence & Space, AOS, Cobham, QinetiQ, Rolls-Royce, Thales

Description: Collaboration between the ASTRAEA consortium and the CAA has positioned the UK as a world leader by regulatory authorities in Europe. This proposal allows the dialogue with the Regulators initiated under ASTRAEA to continue over the next 18-month formative period engaging actively with CAA and consulting with the SME base.

Start date: 1/1/14 | **End Date:** 30/9/15

Attributes: Safety, Cost, Operational Needs & Flexibility

Grant: £0.64m | **Total Cost:** £1.26m

Topic: Unmanned Aerial Systems

113022 – ALFET

Project Title: Advanced Laminar Flow Enabling Technologies

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 10

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, Aircraft Research Association, City University, eStress, GKN Aerospace , Imperial College London, Jigsaw Structures, Manufacturing Technology Centre, National Composites Centre

Description: ALFET aims to improve the understanding and develop the relevant design tools and philosophies in respect of Natural Laminar Flow (NLF), structural design and manufacture. The objective is to deliver the capability of performing multi-disciplinary, integrated design and manufacture of NLF wing aircraft concept which will bring the NLF technology towards TRL6.

Start date: 1/1/14 | **End Date:** 31/12/18

Attributes: Fuel Efficiency

Grant: £10.00m | **Total Cost:** £15.93m

Topic: Multi-physics, Multi-fidelity Modelling

113030 – VALEX

Project Title: Validation and Experimental Capabilities

Value Stream: Aircraft of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Aircraft Research Association, Cranfield University, University of Southampton

Description: The main goal of this project is to develop and enhance experimental aerodynamics capabilities in the UK both by developing experimental competences in the field of high speed and low speed aerodynamics and by developing testing and model manufacturing technologies within state of the art UK wind tunnel facilities.

Start date: 1/4/14 | **End Date:** 31/3/19

Attributes: Fuel Efficiency

Grant: £1.67m | **Total Cost:** £2.50m

Topic: Multi-physics, Multi-fidelity Modelling

113038 – CONGA Ext

Project Title: Configuration Optimisation of Next Generation Aircraft Extension

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, MSC Software

Description: This project develops a selection of innovative capabilities. By bringing together designers and methods developers, it is possible to demonstrate and evaluate the benefits gained from adoption of these enhanced capabilities for a range of potential aircraft architectures, making deployment more effective and paving the way for further future capability enhancement.

Start date: 1/3/14 | **End Date:** 31/3/15

Attributes: Fuel Efficiency, Cost

Grant: £0.89m | **Total Cost:** £1.79m

Topic: Multi-physics, Multi-fidelity Modelling

113073 – ARCADE

Project Title: Aerodynamic Research testing CApability and Data Enhancement

Value Stream: Aircraft of the Future

Time Horizon: Position | **No. of Partners:** 1

Lead Partner: Aircraft Research Association

All Partners: Aircraft Research Association

Description: The aim of this project was to develop specialist rigs for load alleviation, hybrid laminar flow control and flat yaw capabilities to a validated level of maturity, as well as provide air quality improvements to benefit the performance of the Transonic Wind Tunnel (TWT) at the Aircraft Research Association in Bedford.

Start date: 1/6/16 | **End Date:** 31/3/18

Attributes: Fuel Efficiency

Grant: £3.45m | **Total Cost:** £3.45m

Topic: Infrastructure

113074 – WINDY

Project Title: WIng DesigN methodologY validation

Value Stream: Aircraft of the Future

Time Horizon: Position | **No. of Partners:** 7

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, Aircraft Research Association, Cranfield University, Future Advanced Manufacture, National Composites Centre, Renishaw

Description: The WINDY project carries out a programme of research into innovative approaches to wing design and manufacturing processes, as well as undertaking a programme of validation testing in order to demonstrate the effectiveness of future application. The consortium includes airframe designers, manufacturing process specialists and academic researchers.

Start date: 1/5/16 | **End Date:** 31/3/19

Attributes: Fuel Efficiency

Grant: £8.79m | **Total Cost:** £17.57m

Topic: Wing of Tomorrow

113088 – GEMinIDS

Project Title: Geometry Enabled Modelling in Integrated Design Systems

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 9

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Aircraft Research Association, BAE Systems, Cambridge Flow Solutions, Imperial College London, International Technegroup, MBDA, Queen's University Belfast, University of Southampton

Description: GEMinIDS will deliver geometry handling and meshing technology that builds upon the GHandI project whilst extending its scope to Integrated Design Systems. Increasing commercial pressures are demanding ever higher performing products, which in turn need more design iterations and simulation, so the importance of geometry and its integration with the design process and simulation is increasing.

Start date: 1/6/16 | **End Date:** 30/11/19

Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £9.06m | **Total Cost:** £18.12m

Topic: Multi-physics, Multi-fidelity Modelling

113092 – APROCONE

Project Title: Advanced PROduct CONcept analysis Environment

Value Stream: Aircraft of the Future

Time Horizon: Exploit | **No. of Partners:** 8

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, CFMS , Cranfield University, GKN Aerospace , MSC Software, Rolls-Royce, University of Cambridge

Description: APROCONE delivers the capabilities needed to transform the conceptual definition and evaluation of complex products thus providing the foundation on which to achieve significant improvements in development cost and product performance. The consortium of software specialists, industrial end users/suppliers and academic experts will collaborate to investigate innovative aircraft wings & turbofan engines concepts.

Start date: 1/8/16 | **End Date:** 31/1/20

Attributes: Cost

Grant: £9.63m | **Total Cost:** £19.25m

Topic: Multi-physics, Multi-fidelity Modelling

PROPULSION OF THE FUTURE

This theme encompasses the propulsion products and capabilities provided by UK businesses, specifically the technologies, tools, processes and facilities needed to develop and produce them.

The development and manufacture of propulsion systems constitutes around 50% of the sector's direct economic activity, at present concentrated in large engines for wide-body passenger aircraft. The UK supports propulsion in most other aircraft segments through sub-system and component supply to overseas OEMs, and aftermarket services.

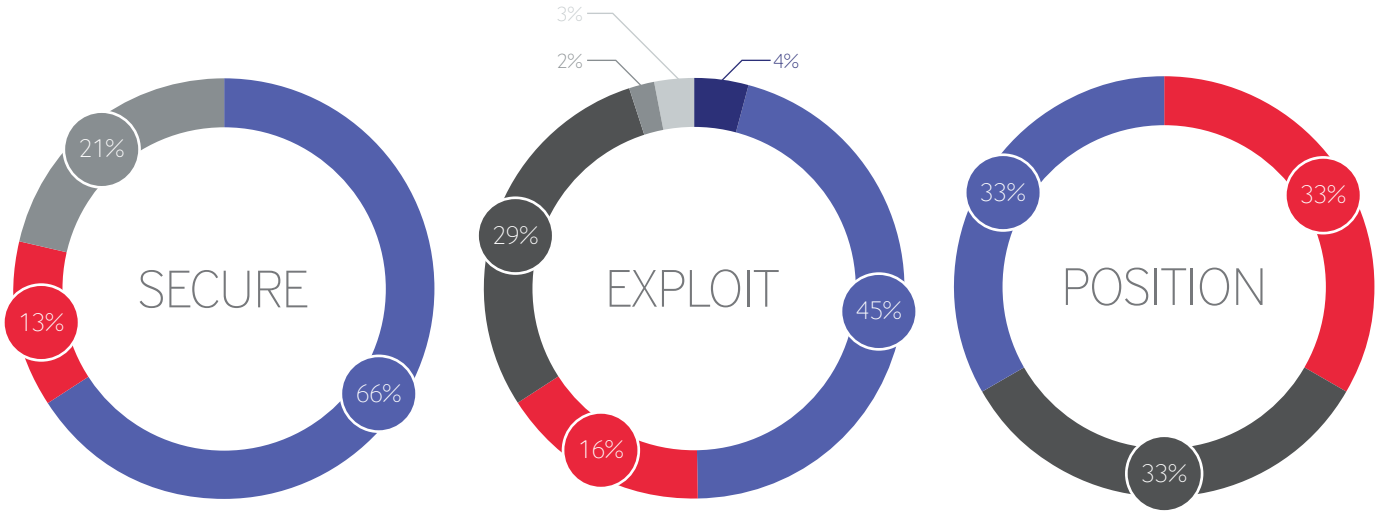
The UK is a world leader in turbofan engines and components, with future opportunities in wide-body, narrow-body and business jet markets. Lighter, higher bypass ratio turbofans with improved thermodynamics are making aircraft more efficient and quieter.

The ATI R&T portfolio is supporting significant developments in new propulsion architectures, technologies and manufacturing capabilities to improve competitiveness and accelerate introduction of new turbofan engines.

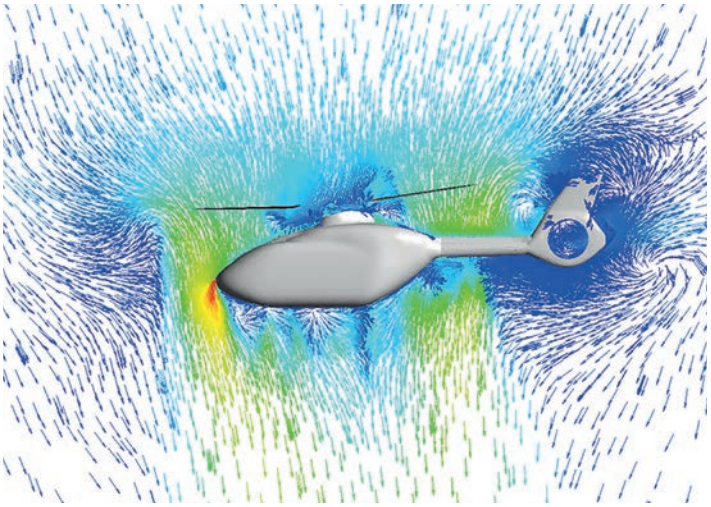
The Propulsion of the Future theme in summary is:

- Realisation of large ultra-high bypass ratio (UHBR) turbofan engines
- Enhancing the integration of advanced propulsion systems onto aircraft
- Developing advanced concepts and demonstration of hybrid and electric distributed propulsion

Safety	Fuel Efficiency	Environment	Cost	Operational Needs & Flexibility	Passenger Experience	Totals
£21.65m	£484.29m	£133.46m	£228.20m	£11.11m	£14.38m	£893.09m



102381 – BLADE-SENSE	
Project Title: Measurement of Dynamic Rotor Blade Deformation	
Value Stream: Propulsion of the Future	
Time Horizon: Exploit	**No. of Partners:** 4
Lead Partner: Airbus Helicopters	
All Partners: Airbus Helicopters, Cranfield University, Helitune, Virtualpie	
Start date: 1/11/15	**End Date:** 30/9/18
Attributes: Safety, Cost, Operational Needs & Flexibility	
Grant: £1.01m	**Total Cost:** £2.02m
Topic: Multi-physics, Multi-fidelity Modelling	



The project's objective is to develop a high-performance, robust instrumentation system capable of operating in the challenging and harsh environment of a helicopter rotor hub. This will provide the capability to monitor the health of the rotor blades through direct measurement of blade shape deformation. Such technology brings benefits to operator and maintainer through continuous in-flight monitoring, which supports inflight safety, operations and maintenance, and contributes towards reductions in point-to-point travel time.

The activities within the project will be focusing on the development of a fibre-optic instrumentation for direct shape deformation measurement, transfer of data between the rotating rotor hub and the airframe and incorporation within a health monitoring solution. With these new technologies able to inform the decision on when to carry out inspections and repairs, it is envisaged that the maintenance costs can be reduced by up to 40%. "BLADE-SENSE is developing unique technologies for accurate, real-time measurement of rotorcraft blade deformation during flight. This research project expands Britain's capability and skills through Airbus Helicopters UK's development and application of world-leading advanced modelling, sensing and flight testing technologies," said Richard Atack Vice-President of Design and Customisation at Airbus Helicopters UK.

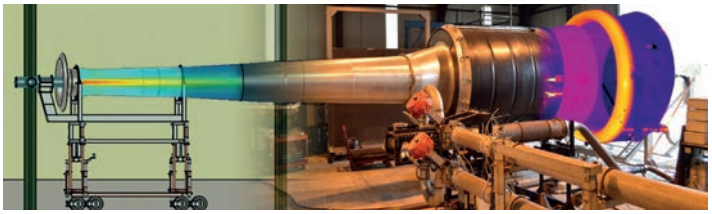
113000 – SILOET 2 P11	
Project Title: Core Demonstrator Concept	
Value Stream: Propulsion of the Future	
Time Horizon: Secure	**No. of Partners:** 1
Lead Partner: Rolls-Royce	
All Partners: Rolls-Royce	
Start date: 1/10/13	**End Date:** 31/3/15
Attributes: Fuel Efficiency, Environment	
Grant: £7.95m	**Total Cost:** £15.91m
Topic: Advanced Core	

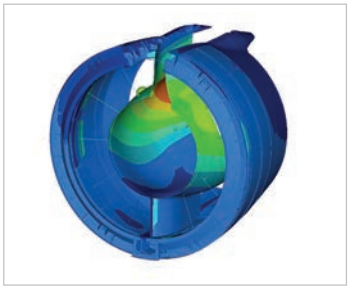
Rolls-Royce has identified that a move to a new core architecture for future large aero engines would offer a degree of efficiency improvement that is not available from further technology evolution of the current Trent architecture. The Core Demonstrator project will confirm the feasibility of new engine concepts and complex effects of system integration ahead of a production related Engine Development Programme (EDP). This specific engine architecture is thought to enable the introduction of new technologies that would reduce the overall Specific Fuel Consumption (SFC) by around 5%, which represents a very significant improvement in the Aircraft Widebody powerplants market targeted by Rolls-Royce.

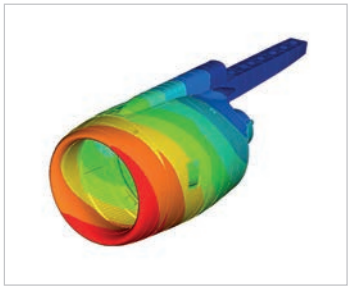
This project specifically covers the preliminary concept definition of the core demonstrator (Stage 1 activities in the Rolls-Royce design process) together with the cost of long lead time materials for the demonstrator that are required to be procured during the project duration. Completion of Stage 1 is a key milestone in the Rolls-Royce design process as it delivers the preliminary concept definition and definition of the overall programme required for successful delivery of the demonstrator including build and testing.

113001 – SANTANA

Project Title: System Advances in Nacelle Technology AerodyNAmics	
Value Stream: Propulsion of the Future	
Time Horizon: Position	**No. of Partners:** 5
Lead Partner: Bombardier Aerospace	
All Partners: Bombardier Aerospace, Aircraft Research Association, City University, Imperial College London, S&C Thermofluids	
Start date: 1/1/14	**End Date:** 31/3/18
Attributes: Fuel Efficiency, Environment, Cost	
Grant: £3.80m	**Total Cost:** £6.92m
Topic: Ultra-high Bypass Ratio Engines	







SANTANA is a collaborative programme focused on developing aerodynamic technologies for the design of advanced Ultra-high Bypass Ratio (UHBR) power plant nacelles. The nacelle on a modern high bypass ratio engine is a significant contributor to power weight and, owing to its size, can also have a marked impact on aircraft fuel burn performance. Targeting nacelle components for next-generation aircraft, SANTANA exploits new lower-weight structural designs to reduce performance losses associated with installed nacelle systems. It also develops advanced aerodynamic testing methods and improvements to laminar-turbulence modelling and testing facilities in the UK.

The project has progressed key technologies from TRL3 to TRL5, achieving component weight reductions of up to 20% and nacelle aerodynamic drag reductions of up to 5%. The technologies developed through SANTANA mean that the UK has enhanced its competitiveness and readiness for selection as the nacelle supplier for future programmes. Project lead Bombardier is now better positioned to potentially increase its share of the nacelles market. "The availability of test facilities within the UK, providing a representative environment for evaluation of nacelle component system performance, will help develop the enabling technologies at a more rapid pace," said David Riordan, Chief Technical Engineer at Bombardier Belfast.

113002 – RTVP 2

Project Title: Extension to the Rotorcraft Technology Validation Programme	
Value Stream: Propulsion of the Future	
Time Horizon: Exploit	**No. of Partners:** 1
Lead Partner: Leonardo Helicopters	
All Partners: Leonardo Helicopters	
Start date: 1/7/13	**End Date:** 30/11/15
Attributes: Fuel Efficiency, Cost, Passenger Experience	
Grant: £2.13m	**Total Cost:** £4.25m
Topic: Through-life	

Leonardo Helicopters is continuing research into helicopter active rotor technology – representing the next big step in helicopter capability enhancement and providing the ability to improve helicopter performance and comfort. The Rotorcraft Technology Validation Programme (RTVP) is the culmination of effort to design, develop, manufacture and test active trailing edge technology embedded within a real helicopter blade. Previous projects developed design, methodologies and simulation tools for moving trailing edge flaps on helicopter blades.

The technologies are expected to provide up to 90% reduction in vibration, with potential to increase helicopter critical speeds by up to 10%, reduce the cost of vibration-attributed maintenance and also reduce noise. Once these technologies are validated they can be developed and embodied in the wider range of helicopters. "Many important lessons have been learnt during these projects, and the active rotor is now undergoing a programme of ground testing to clear the final design for flight", said Simon Stacey, Chief Project Engineer for active rotors at Leonardo Helicopters. "ATI support has enabled high-risk technology development to be carried out offline from normal product development."

101368 – NADIT

Project Title: Novel Aerodynamic Design & Integration Technologies

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 5

Lead Partner: Rolls-Royce

All Partners: Cranfield University, Imperial College London, Loughborough University, Rolls Royce, University of Cambridge

Description: NADIT aims to dramatically reduce fuel and environmental impact in gas turbines by developing several novel design concepts for the fan, compressor, installation and combustor, significantly improving engine performance. Utilising modern experimental and computational techniques, improvements to the integration of individual engine sub-systems are enhanced, producing a system-optimised engine design.

Start date: 1/3/13 | **End Date:** 30/6/16

Attributes: Fuel Efficiency

Grant: £2.16m | **Total Cost:** £4.32m

Topic: Advanced Core

101369 – TuFT

Project Title: Turbo-machinery Flow and Turbulence

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University of Cambridge

Description: TuFT will accelerate the understading of several key high potential aerodynamic technologies, investigating accurate modelling and understanding of turbo-machinery flow for the design of high performance, low emission turbo machines. The project will also contribute to meeting the requirements of future engines and changes in architecture that will improve performance.

Start date: 1/3/13 | **End Date:** 31/3/16

Attributes: Fuel Efficiency

Grant: £2.16m | **Total Cost:** £4.26m

Topic: Advanced Core

101794 – AMSCA

Project Title: Accelerated Manufacturing with Chrome Free Sacrificial Cermet Coatings in Aerospace

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 8

Lead Partner: Monitor Coatings

All Partners: Monitor Coatings, Ashton & Moore, Granta Design, Indestructible Paint, Loughborough University, Manufacturing Technology Centre, Rolls-Royce, University of Birmingham

Description: AMSCA aims to formulate a new sacrificial coating for corrosion protection of steel aero-engine components that is free from hexavalent chromium and demonstrate the technology to TRL5. In addition, improved, cost-effective application methodology will be developed, incorporating automation where appropriate, to increase manufacturing rate and capacity and reduce waste.

Start date: 1/6/14 | **End Date:** 30/11/17

Attributes: Environment

Grant: £1.54m | **Total Cost:** £2.33m

Topic: Manufacturing Processes

101801 – HiTDevS

Project Title: High Throughput Development of Superalloys

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Ilika Technologies

All Partners: Ilika Technologies, Diamond Light Source, University of Cambridge

Description: HiTDevS identified new alloy compositions for use in gas turbine engines which provide better thermo efficiency than current alloys, increasing performance and reducing CO2 emissions and noise levels at take-off. High-throughput or combinatorial techniques involving the rapid synthesis of many different structurally related materials in a few automated steps, was developed through this project.

Start date: 1/4/14 | **End Date:** 31/10/17

Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £1.32m | **Total Cost:** £1.89m

Topic: Advanced Core

102360 – FLARE

Project Title: FLame spray Adder for in-situ patch Repair of aero-Engine combustors

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Metallisation, University of Nottingham

Description: FLARE is a project utilising continuum robot capability developed by the University of Nottingham, and incorporating miniaturised flame spray equipment from Metallisation. It focuses on the creation of a device that can perform in-situ/on-wing patch repair of flame sprayed coatings without dismantling high value infrastructure e.g. aircraft jet engines.

Start date: 1/10/15 | **End Date:** 31/12/18

Attributes: Cost

Grant: £0.75m | **Total Cost:** £1.50m

Topic: Through-life

102369 – HEATSSIM

Project Title: Holistic Engineering Approach to Thermal and Structural Simulation

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Romax Technology

All Partners: Romax Technology, ANSYS, University of Nottingham

Description: HEATSSIM is delivering an optimised design process for aerospace gearboxes, providing a step-change in the design and analysis methods for the development of state-of-the-art and future aerospace transmission systems.

Start date: 1/9/15 | **End Date:** 31/8/18

Attributes: Fuel Efficiency

Grant: £0.51m | **Total Cost:** £1.03m

Topic: Multi-physics, Multi-fidelity Modelling

102378 – TB-REMAN

Project Title: Autonomous Aero Turbine Blade Re-Manufacturing System

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: VBC Instrument Engineering

All Partners: VBC Instrument Engineering, Advanced Manufacturing Research Centre

Description: TB-REMAN is providing a fully automated solution for that can identify both wear on gas turbine blades and carries out repairs. From application of novel techniques and technology made in the UK, increased production throughput and data will allow manufacturers to see benefits such as increased service life, optimised blade design and increased efficiency.

Start date: 1/9/15 | **End Date:** 31/8/18

Attributes: Cost, Operational Needs & Flexibility

Grant: £1.16m | **Total Cost:** £2.32m

Topic: Through-life

102380 – REMASTER

Project Title: REpair Methods for Aerospace STructures using novEl pRocesses

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, 3T RPD, Advanced Manufacturing Research Centre

Description: REMASTER is investigating removing damage from high value components and then using additive technologies to restore component geometry and material performance. Further research into material development to ensure the integrity of the repairs and novel joining techniques is also explored as part of this project.

Start date: 1/1/16 | **End Date:** 31/12/18

Attributes: Cost, Operational Needs & Flexibility

Grant: £1.74m | **Total Cost:** £3.48m

Topic: Through-life

110056 – NGVL P1

Project Title: Next Generation Vertical Lift Programme - Blades

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Leonardo Helicopters

All Partners: Leonardo Helicopters, University of Liverpool

Description: Next Generation Vertical Lift project on Blades covered design, development, manufacture and testing of prototype, high efficiency, blades for helicopter main and tail rotor. The project also worked on novel modelling methods for predicting helicopter ditching performance, which is a safety critical requirement.

Start date: 1/10/10 | **End Date:** 31/3/14

Attributes: Fuel Efficiency, Cost

Grant: £3.30m | **Total Cost:** £9.35m

Topic: Manufacturing Processes

110057 – NGVL P2

Project Title: Next Generation Vertical Lift Programme - Transmission

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Leonardo Helicopters

All Partners: Leonardo Helicopters, Chris Walters , Stone Foundries

Description: Next Generation Vertical Lift project on Hubs and Transmissions covered innovative technologies associated with the MRO of high-value vital parts, cold metal spraying, metal injection moulding, laser shot peening and cold turning. The project also addressed product component technologies including successful exploitation of a novel damper concept.

Start date: 1/10/10 | **End Date:** 31/3/14

Attributes: Fuel Efficiency, Cost

Grant: £4.13m | **Total Cost:** £12.34m

Topic: Manufacturing Processes

110060 – RTVP

Project Title: Rotorcraft Technology Validation Programme

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Leonardo Helicopters

All Partners: Leonardo Helicopters, National Composites Centre, University of Liverpool

Description: RTVP designed, developed, manufactured and tested an active trailing edge embedded within a real helicopter blade. Focusing on three key technologies; Active Rotor Systems, Active Vibration Management Systems and Rotor Health and Usage Monitoring, the programme represented the next big step in helicopter capability enhancement, providing the ability to improve helicopter performance and comfort.

Start date: 1/4/10 | **End Date:** 31/3/14

Attributes: Fuel Efficiency, Cost, Passenger Experience

Grant: £5.88m | **Total Cost:** £15.46m

Topic: Through-life

110100 – SAMULET 2 P1

Project Title: Tighter Specification Aerofoils

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Forming Research Centre, Advanced Manufacturing Research Centre

Description: The project aimed to develop manufacturing processes enabling cost competitive manufacture of advanced aerofoil designs which rotate at high speeds and efficiently compress the incoming air. These included: new forging methods; optimised machining; improving the Superplastic Forming process. The project aimed to achieve 30% productivity improvement and 100% right-first-time.

Start date: 1/4/12 | **End Date:** 31/12/15

Attributes: Fuel Efficiency

Grant: £2.90m | **Total Cost:** £5.78m

Topic: Manufacturing Processes

110101 – SAMULET 2 P2

Project Title: High Performance Shaft Machining

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Forming Research Centre, Advanced Manufacturing Research Centre

Description: The aim of this project was to develop methods and technologies to deliver step-change improvements in the manufacture of aero-engine shaft components, to achieve reduced cycle times and manual intervention, and improved Right First Time (RFT). Such improvements are necessary to enable Rolls-Royce to deliver the volume of shafts required to meet the growing global demand for the Trent XWB.

Start date: 1/4/12 | **End Date:** 31/12/15

Attributes: Cost

Grant: £3.16m | **Total Cost:** £6.31m

Topic: Manufacturing Processes

110102 – SAMULET 2 P3

Project Title: Affordable Blisks

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Manufacturing Technology Centre

Description: The main aim of the Affordable Blisk project was to develop technologies to significantly reduce manufacturing lead time and cost for these complex aerospace components. A blisk (bladed disc) is created as single part by the joining of a blade to a disc using solid state joining techniques, enabling substantial weight and performance benefits, when compared to conventional disc/blades arrangements.

Start date: 1/4/12 | **End Date:** 31/12/15

Attributes: Cost

Grant: £1.73m | **Total Cost:** £8.48m

Topic: Manufacturing Processes

110103 – SAMULET 2 P4

Project Title: Next Generation Fan System

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, GKN Aerospace , National Composites Centre

Description: This project sought to develop, understand and demonstrate aspects of manufacturing technologies required to produce composite fan blades ranging in length from 60" to 140". Specific areas of research included: cost reduction; development of manufacturing methods for structural metalwork to strict tolerances; and improvements to blade assembly techniques.

Start date: 1/4/12 | **End Date:** 31/1/15

Attributes: Fuel Efficiency, Cost

Grant: £6.85m | **Total Cost:** £17.12m

Topic: Ultra-high Bypass Ratio Engines

110104 – SAMULET 2 P5

Project Title: Advanced Fabrication

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Manufacturing Technology Centre

Description: The project concentrated on advancing automated welding techniques, using robots to weld outlet guide vane components. Also, developing new laser welding techniques for joining various configurations of thin-walled aerospace materials, and the laser drilling of combustion tiles enabling the benefits of the early laser technology to be applied onto critical aerospace components.

Start date: 1/4/12 | **End Date:** 31/12/15

Attributes: Cost

Grant: £1.86m | **Total Cost:** £3.78m

Topic: Manufacturing Processes

110105 – SAMULET 2 P6

Project Title: Powder Consolidation Technologies

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Manufacturing Technology Centre

Description: Aimed at developing a new powder Hot Isostatic Pressure process to manufacture combustor casings from new high temperature materials, enabling increased operating temperatures and pressures. Engine section stator vanes were also targeted to develop alternative technology to casting and forging. This should reduce both input weight and manufacturing costs for these complex aerospace components.

Start date: 1/4/12 | **End Date:** 31/12/15

Attributes: Fuel Efficiency

Grant: £3.65m | **Total Cost:** £10.07m

Topic: Additive Manufacture

110106 – SAMULET 2 P7

Project Title: Processing of High Temperature Materials

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University of Birmingham

Description: Focussed on delivering a step change in dimensional control of turbine blade manufacture through new casting ceramic material formulations, with suitably low strength at solidification temperatures. In addition, the project developed a fully adaptive machining solution for the finishing of turbine blades, with improved control of aerofoil shape and wall thickness.

Start date: 1/4/12 | **End Date:** 31/12/15

Attributes: Fuel Efficiency

Grant: £1.06m | **Total Cost:** £5.42m

Topic: Manufacturing Processes

110107 – SAMULET 2 P8

Project Title: Emerging Manufacturing Technologies

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Manufacturing Technology Centre, Rolls-Royce

Description: This project has explored several new, low TRL technologies, to understand applications in future aerospace components. Automated assembly and inspection, advanced tooling development, improvements to welding capability, and modelling methods to predict manufacturing processes, will deliver improvements to manufacturing time, and significant cost reductions. Rolls-Royce has detailed plans to develop these technologies and implement into its UK production facilities.

Start date: 1/4/12 | **End Date:** 31/12/15

Attributes: Fuel Efficiency, Cost

Grant: £3.78m | **Total Cost:** £9.27m

Topic: Manufacturing Processes

110110 – IMPACTA

Project Title: Improving the Propulsion Aerodynamics of Turboprop Aircraft

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: GE Aviation Systems

All Partners: GE Aviation Systems, Aircraft Research Association, University of Liverpool

Description: IMPACTA identified several aerodynamic and acoustic innovations to improve the noise and efficiency of turboprop aircraft, developing advanced analysis tools and alongside wind tunnel tests to advance the technologies into practical solutions. The project identified a number of design improvements expected to yield significant improvements in installed propeller efficiency and noise.

Start date: 1/6/12 | **End Date:** 31/3/16

Attributes: Fuel Efficiency, Environment, Passenger Experience

Grant: £1.94m | **Total Cost:** £3.89m

Topic: Multi-physics, Multi-fidelity Modelling

110116 – SILOET 2 P2

Project Title: Lightweight Fan System Technology Development

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University Of Oxford

Description: The project aims to develop fan system technologies for future civil aerospace gas turbine engines. New technologies will help reduce weight and resultant CO2 emissions. This project takes new designs of fan system components to carry out a range of mechanical and environmental testing in rigs leading up to full system testing.

Start date: 1/7/12 | **End Date:** 30/6/16

Attributes: Fuel Efficiency

Grant: £3.20m | **Total Cost:** £6.50m

Topic: Ultra-high Bypass Ratio Engines

110117 – SILOET 2 P3

Project Title: Lightweight Fan System Design and Operation

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, GKN Aerospace , National Composites Centre

Description: This project developed a composite fan system for future civil gas turbine engines to deliver a significant weight saving. This included a robust liner system that protects the casing and enables a lighter weight structure, a robust tip-rubbing capability for the blade tip, fire-proofing the composite casing, and of Non Destructive Testing (NDT) capabilities to inspect the containment case and liner.

Start date: 1/7/12 | **End Date:** 31/12/15

Attributes: Fuel Efficiency, Cost

Grant: £3.30m | **Total Cost:** £6.60m

Topic: Ultra-high Bypass Ratio Engines

110118 – SILOET 2 P4

Project Title: Lightweight Composite Casing Manufacturing Development

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, GKN Aerospace

Description: The project demonstrated composite fan case manufacturing capability on representative development equipment, and identified additional required work required for production equipment. Composite fan cases for the system level engine test programme were manufactured through this project. A reduction in the cost of the composite manufacturing method has been achieved through process optimisation and development of automated methods.

Start date: 1/7/12 | **End Date:** 31/12/14

Attributes: Fuel Efficiency

Grant: £3.50m | **Total Cost:** £7.00m

Topic: Ultra-high Bypass Ratio Engines

110119 – SILOET 2 P5

Project Title: High-temperature Seals and Oil System

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, University of Nottingham, University Of Oxford

Description: The aim of the project was to develop improved high-temperature air-air seals, bearing-chamber dynamic seals and static seals. In addition to the engine efficiency improvements, developing an advanced sealing capability is an enabler for novel engine architectures with simplified air and oil systems having lower complexity, lower weight, and optimised overall system level performance.

Start date: 1/1/13 | **End Date:** 31/12/16

Attributes: Fuel Efficiency

Grant: £2.26m | **Total Cost:** £4.27m

Topic: Advanced Core

110120 – SILOET 2 P6

Project Title: High-temperature Capability - Compressor and Discs

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Swansea University, University of Nottingham, University of Surrey

Description: Focused on 4 different aspects of high temperature compressor technologies. Developing, axial compressors through design and improved aerofoil materials to withstand temperatures over 700°C; manufacture of abradable liners and abradable tipping of blades to reduce leakage; high-temperature, high-strength, single piece shaft steel. Also demonstrating capability of RR1000 high temperature disc material, reducing Specific Fuel Consumption (SFC) and increasing part life.

Start date: 1/1/13 | **End Date:** 31/12/16

Attributes: Fuel Efficiency

Grant: £4.72m | **Total Cost:** £9.45m

Topic: Advanced Core

110121 – SILOET 2 P7

Project Title: Robust Low Cost Combustion

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Loughborough University, University of Cambridge

Description: To improve prediction of component lives, develop new combustor high temperature alloys and validated cooling designs to increase cooling efficiency and reduce cost. In addition, developing a suite of tools to optimise cooling design from low TRL, enhance Lean Burn technology and improve the interface design between combustor and turbine modules, reducing fuel consumption.

Start date: 1/1/13 | **End Date:** 31/3/16

Attributes: Fuel Efficiency

Grant: £2.16m | **Total Cost:** £4.32m

Topic: Advanced Core

110122 – SILOET 2 P8

Project Title: High-temperature Turbine Technology and Demonstration

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Swansea University, University of Cambridge, University Of Oxford

Description: A collaborative project to develop turbine technologies for future civil aerospace gas turbine engines. New technologies will help reduce fuel consumption, improve component life and life predictions. Fundamental and applied research will be pulled through to representative engine components for tests, in rigs and full system testing in a high temperature demonstrator engine.

Start date: 1/10/12 | **End Date:** 31/12/18

Attributes: Fuel Efficiency

Grant: £10.36m | **Total Cost:** £20.72m

Topic: Advanced Core

110123 – SILOET 2 P10

Project Title: Virtual Engine Design Systems

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 7

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Imperial College London, Loughborough University, University of Cambridge, University of Leeds, University Of Oxford, University of Southampton

Description: The aim of the project is to deal with process integration, and automation from preliminary design, to fully detailed whole engine modelling; and to support the engineering community by providing faster and better solutions to the engine design process. The project addressed innovations to improve its ability to produce products that reliably meet challenging requirements

Start date: 1/10/12 | **End Date:** 30/9/16

Attributes: Cost

Grant: £4.49m | **Total Cost:** £8.99m

Topic: Multi-physics, Multi-fidelity Modelling

110124 – SILOET 2 P9

Project Title: Integrated Accessories Raft System

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, BF1, National Composites Centre

Description: Several critical systems for Rolls-Royce engines are located on the fan case. This project technology embeds this complex network of dressings into composite rafts. This technology will deliver a 30% part count reduction, weight reduction, build time/cost savings and a predicted 50% reduction of in-service reliability issues.

Start date: 1/1/13 | **End Date:** 30/6/15

Attributes: Fuel Efficiency, Cost

Grant: £2.00m | **Total Cost:** £4.00m

Topic: More electric aircraft

113006 – SAMULET 2 P10

Project Title: Fast Make Technologies

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Forming Research Centre, Advanced Manufacturing Research Centre, Manufacturing Technology Centre, University of Birmingham

Description: The aim is to reduce lead times from concept to manufacture by 75% for demonstrator engines. This reduces the risk of expensive redesign, as Fast Make allows time for more iterations to improve engine performance. Successful examples developed include; 3D sand printing technology, shear forming, and automatic Co-ordinate Measuring Machine (CMM) program generation.

Start date: 1/10/13 | **End Date:** 30/6/16

Attributes: Safety, Fuel Efficiency, Environment, Cost

Grant: £5.51m | **Total Cost:** £11.02m

Topic: Manufacturing Processes

113007 – SILOET 2 P15

Project Title: Advanced Turbine Technologies

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University of Cambridge

Description: Developing a range of turbines technologies that support the drive for higher Turbine Entry Temperatures (TET), whilst also supporting the development of the understanding of the High-Pressure Turbine (HPT) interface with rich-burn combustors operating at very high temperatures. This is required for the large civil engine applications such as the Trent XWB 97K.

Start date: 1/10/13 | **End Date:** 30/6/17

Attributes: Fuel Efficiency, Environment

Grant: £6.54m | **Total Cost:** £13.02m

Topic: Advanced Core

113010 – SILOET 2 P18

Project Title: Future Core Engine Systems

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, University of Nottingham, University Of Oxford

Description: Includes programmes on cooled cooling air, advanced turbine tip clearance control, turbine blade release containment, oil systems, bearing load management, elevating fuel operating temperature, adaptive internal air systems, and advanced seals. All the work packages propose innovation of system technologies critical to the next generation large civil engine core architectures.

Start date: 1/10/13 | **End Date:** 31/12/16

Attributes: Fuel Efficiency, Environment

Grant: £8.98m | **Total Cost:** £17.96m

Topic: Advanced Core

113011 – SILOET 2 P20

Project Title: Core Demonstrator Detailed Design

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce

Description: To develop the detailed design of an aero gas turbine core demonstrator, to verify advanced technologies for next generation of civil engines at a whole system level. In establishing the detailed design, the project will prove the feasibility of the demonstrator and reduce the risks associated with the demonstrator to a level allowing manufacture of the demonstrator.

Start date: 1/5/14 | **End Date:** 31/1/15

Attributes: Fuel Efficiency

Grant: £8.32m | **Total Cost:** £16.63m

Topic: Advanced Core

113012 – SILOET 2 P12

Project Title: Advanced High Pressure Ratio Efficient Compressor Technology

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce

Description: The design, make, test and data analysis for an advanced high pressure ratio compressor. This compressor is required to meet the environmental targets with new wide body aircraft with an EIS of 2020 and beyond. Building on previous projects to achieve efficiency beyond the state of the art and will provide TRL5 validation.

Start date: 1/10/13 | **End Date:** 30/9/16

Attributes: Fuel Efficiency, Environment

Grant: £8.36m | **Total Cost:** £16.71m

Topic: Advanced Core

113013 – SILOET 2 P13

Project Title: Engine Installation Analytics for Future Novel Architectures

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Cranfield University, Loughborough University, University of Cambridge, University of Southampton

Description: Aerodynamic and aero acoustic prediction for use in multi-disciplinary optimisation design to address challenges associated with higher bypass ratio engines concepts, for entry into service after 2020. Providing a step change in nacelle aerodynamic and aero acoustic modelling capability within the aircraft installed environment, validated by high fidelity measured data.

Start date: 1/1/14 | **End Date:** 31/3/17

Attributes: Environment

Grant: £2.34m | **Total Cost:** £4.67m

Topic: Multi-physics, Multi-fidelity Modelling

113015 – SAMULET 2 P11

Project Title: Advanced Repair Technologies

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, European Thermodynamics, Swansea University, University of Birmingham, University of Nottingham

Description: This project developed and demonstrated three key advanced repair technologies to address the increasing complexity of future aero engine components. Including, cost-efficient high-integrity repair of blisks, on-platform repair and structural repair of composite components. These repair processes must be capable of being applied to complex geometries and accommodate component variation resulting from service operation.

Start date: 1/1/14 | **End Date:** 31/3/17

Attributes: Cost

Grant: £4.54m | **Total Cost:** £9.14m

Topic: Through-life

113016 – SILOET 2 P14

Project Title: Aero-mechanically Optimised Composite Fan System

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce

Description: Aimed to introduce a carbon fibre composite fan system on to next generation Rolls-Royce engines, enabling lightweight and greater fatigue resistant components. The project includes design and tooling for the next generation composite fan system, aimed at meeting future large engine market. It also includes mechanical and environmental testing to validate such designs.

Start date: 1/1/14 | **End Date:** 31/3/17

Attributes: Fuel Efficiency

Grant: £8.40m | **Total Cost:** £16.80m

Topic: Manufacturing Processes

113017 – SILOET 2 P19

Project Title: CMC and High Temperature Technologies

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Imperial College London, Swansea University

Description: Focused on the development of new high temperature turbine capability. The application of novel Ceramic Matrix Composites (CMC) are explored as a potential new material system in the turbine cores. Several other technologies including new alloy chemistry and protective coatings have been developed. Testing will be carried out at specimen, component and sub-system level in rigs and engines.

Start date: 1/1/14 | **End Date:** 31/3/17

Attributes: Fuel Efficiency, Environment, Cost

Grant: £6.30m | **Total Cost:** £12.59m

Topic: Advanced Core

113018 – SILOET 2 P17

Project Title: RR1000 – High Temperature Nickel Alloy

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Swansea University, University Of Oxford

Description: Delivering three key work-packages to a technology readiness level that enables high temperature nickel alloy exploitation in future engines: powder hot Isostatic pressing of RR1000 (Rolls-Royce alloy invention) for application in the combustion chamber outer casing, validated RR1000 high temperature disc material capability and joining of RR1000 for high temperature high pressure drum capability.

Start date: 1/1/14 | **End Date:** 30/9/17

Attributes: Fuel Efficiency, Cost

Grant: £8.34m | **Total Cost:** £16.69m

Topic: Advanced Core

113034 – SAMULET 2 P9

Project Title: Composite Fan System Manufacturing Development

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Manufacturing Technology Centre, National Composites Centre

Description: Developing automated methods for manufacture a composite fan system. Carbon/titanium blades are a key feature of the Rolls-Royce Advance engine, and provide a 1,500lb weight saving. A pre-production facility to test these manufacturing techniques has been set up, alongside the carbon-fibre electrical harness rafts facility, to create a hub of composite knowledge in the Bristol area.

Start date: 1/1/14 | **End Date:** 31/12/16

Attributes: Safety, Fuel Efficiency, Cost

Grant: £9.77m | **Total Cost:** £19.53m

Topic: Manufacturing Processes

113046 – MAMOTH PGB

Project Title: Materials, Manufacturing and Oils Technologies for High Power Gearbox systems

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 9

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Forming Research Centre, Advanced Manufacturing Research Centre, Manufacturing Technology Centre, McLaren Racing, Newcastle University, Swansea University, Tata Steel Europe, University of Nottingham

Description: A key feature of Rolls-Royce's new engine architecture, is the development of a high power gearbox that can operate at very high speeds and loads, while delivering an acceptable service life. This project conducted research into the development of new materials, coatings and oils, and the optimisation of high precision manufacturing processes.

Start date: 1/12/14 | **End Date:** 30/11/18

Attributes: Fuel Efficiency

Grant: £6.87m | **Total Cost:** £13.75m

Topic: Advanced Core

113049 – Combustions Systems

Project Title: National Centre of Excellence in Gas Turbine Combustion Aerodynamics

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Loughborough University

All Partners: Loughborough University

Description: A National Centre of Excellence in Combustion Aerodynamics will be established at Loughborough University, bringing together academic and industrial researchers from partners such as Rolls-Royce to develop the next generation of future, low emission, aerospace gas turbine combustion systems, whilst also training future engineers capable of delivering this technology.

Start date: 1/8/15 | **End Date:** 31/5/19

Attributes: Environment

Grant: £10.80m | **Total Cost:** £10.80m

Topic: Infrastructure

113050 – ARGON

Project Title: ARGON

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce

Description: This project aims to ensure UK capability on lean burn fuel spray nozzles to ensure the emissions performance for aerospace engines can be competitive for future engines, that meets emission targets and legislation. Specifically, novel lean burn fuel spray design and manufacturing capability will be established in the UK.

Start date: 1/7/14 | **End Date:** 31/3/18

Attributes: Environment

Grant: £2.98m | **Total Cost:** £5.95m

Topic: Advanced Core

113054 – HPTFS

Project Title: Two-shaft Resource for Investigation of Engineering Phenomena in High Performance Transmission Systems Facility

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: University of Nottingham

All Partners: University of Nottingham

Description: Under this project, a two-shaft test rig facility will be built at the University of Nottingham's University Technology Centre (UTC). The facility will allow the UTC, Rolls Royce and other businesses to test and evaluate new technologies for the development of engine and power gas-turbine oil systems and bearing chambers.

Start date: 1/4/15 | **End Date:** 30/9/18

Attributes: Fuel Efficiency, Environment

Grant: £2.61m | **Total Cost:** £2.61m

Topic: Infrastructure

113056 – NADD

Project Title: New Architecture Detail Design

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 1

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce

Description: This project aims to accelerate the development and introduction of the new advance large engine core architecture as well as other key technologies through the detail design of a new core engine architecture. The project objective will be to develop an all new core turbomachinery architecture.

Start date: 1/2/15 | **End Date:** 31/12/15

Attributes: Fuel Efficiency, Environment

Grant: £14.50m | **Total Cost:** £29.00m

Topic: Multi-physics, Multi-fidelity Modelling

113063 – FASTMAKE

Project Title: Fast Make for Demonstrators and Low Volume

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce

Description: This project will develop a highly responsive UK fast make manufacturing capability to support the anticipated demand for research and experimental components. The project will develop fast make business process, select UK manufacturing sources and launch manufacturing plans to produce parts and develop capabilities.

Start date: 1/4/15 | **End Date:** 31/12/16

Attributes: Cost

Grant: £6.00m | **Total Cost:** £12.00m

Topic: Manufacturing Processes

113072 – NPA

Project Title: Ultra-high Temperature Nickel Powder Alloy

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Cranfield University, University of Birmingham, University of Cambridge

Description: Rolls-Royce is developing a new high temperature nickel alloy to be used in future engines. This alloy will allow the engine core to operate at higher speeds and temperatures to achieve the efficiency required, while still delivering acceptable service life. Furthermore, suitable coatings are being developed to enhance component capabilities.

Start date: 1/3/16 | **End Date:** 31/8/19

Attributes: Fuel Efficiency

Grant: £7.80m | **Total Cost:** £15.60m

Topic: Through-life

113075 – iFan

Project Title: Integrated Fan Technologies

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Cranfield University, Imperial College London, University of Cambridge

Description: iFan is developing and validating the aerodynamic capabilities needed to design a novel integrated fan-intake system for Rolls-Royce UltraFan™ engine concept. This will enable shorter intakes and slimline nacelles to be used (with lower weight and drag), whilst managing the effect on fan efficiency and operability.

Start date: 1/4/16 | **End Date:** 31/3/20

Attributes: Fuel Efficiency

Grant: £9.50m | **Total Cost:** £19.00m

Topic: Ultra-high Bypass Ratio Engines

113076 – iCORE

Project Title: Integrated Core Technologies

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 5

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Cranfield University, Loughborough University, University of Cambridge, University Of Oxford

Description: This project is a collection of aerothermal technology developments focused around the core of a civil gas turbine engine with the common theme of reducing overall engine fuel burn. These developments target new technology that impacts fuel burn in future engine designs, such as the Rolls-Royce UltraFan™ engine concept.

Start date: 1/4/16 | **End Date:** 31/3/20

Attributes: Fuel Efficiency, Environment

Grant: £8.37m | **Total Cost:** £16.73m

Topic: Ultra-high Bypass Ratio Engines

113078 – PROFILE

Project Title: Pressure Ratio Optimised Fan Integral to Low speed Engines

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University Of Oxford

Description: A fundamental enabler for the UltraFan™ architecture is the development of a large diameter, low speed, low pressure ratio fan system. This entails technical challenges including structural integration of the fan into a geared architecture and integrity of the blades during impact scenarios. This project investigates and mitigate these challenges.

Start date: 1/4/16 | **End Date:** 31/3/18

Attributes: Fuel Efficiency

Grant: £6.95m | **Total Cost:** £13.90m

Topic: Advanced Core

113081 – MPP P2

Project Title: Manufacture of Advanced Material

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Forming Research Centre, Advanced Manufacturing Research Centre

Description: This project will accelerate the development of technologies that enable the manufacture of aerospace components made from advanced materials. The early focus on these technologies will ensure high productivity processes are established at an appropriate pace to allow competitive industrialisation for future engine products.

Start date: 1/4/16 | **End Date:** 31/3/20

Attributes: Fuel Efficiency, Cost

Grant: £9.47m | **Total Cost:** £18.94m

Topic: Advanced Core

113082 – MPP P7

Project Title: High Performance Carbon Titanium Fan Blade Manufacturing

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, National Composites Centre

Description: This project aims to strengthen the competitiveness of UK high value manufacturers by delivering and demonstrating breakthrough composite manufacturing technologies. The work packages will be developed by Rolls-Royce working in partnership with the National Composites Centre (NCC) and utilising the UK manufacturing supply chain.

Start date: 1/4/16 | **End Date:** 30/4/20

Attributes: Fuel Efficiency, Cost

Grant: £9.80m | **Total Cost:** £19.60m

Topic: Advanced Core

113083 – MPP P5

Project Title: Enhanced Turbine Manufacture for Performance and Cost

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Manufacturing Technology Centre, University of Birmingham

Description: This project will develop high product efficiency and high productivity turbine manufacturing methods. It will include machining, coating, modelling and inspection technology development. The project will be lead by Rolls-Royce in partnership with the MTC, the AMRC, the University of Birmingham and using the UK manufacturing services supply chain.

Start date: 1/4/16 | **End Date:** 31/3/20

Attributes: Fuel Efficiency, Cost

Grant: £8.16m | **Total Cost:** £16.31m

Topic: Manufacturing Processes

113084 – MPP P1

Project Title: High Performance Rotating Components

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Manufacturing Technology Centre, University of Birmingham

Description: This project will develop technologies for the manufacture of gas turbine discs, blisks and rotating assemblies. Innovative modelling, manufacturing process optimisation and efficient validation regimes will be developed to significantly enhance current and future engine designs, utilising the UK manufacturing services supply chain.

Start date: 1/4/16 | **End Date:** 31/3/20

Attributes: Fuel Efficiency, Cost

Grant: £4.48m | **Total Cost:** £8.96m

Topic: Advanced Core

113085 – CTiFan

Project Title: CTI Composite Fan Technology

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Imperial College London, National Composites Centre

Description: The purpose of this project t is to complete the development of carbon fibre composite materials for use in a lightweight fan system for high bypass ratio direct drive turbofans. It will focus on modelling the propagation of damage, general damage tolerance and environmental effects of moisture and temperature variation.

Start date: 1/11/16 | **End Date:** 31/7/19

Attributes: Fuel Efficiency

Grant: £9.18m | **Total Cost:** £18.37m

Topic: Ultra-high Bypass Ratio Engines

113086 – ACAPELLA

Project Title: Assessment Capability for Advanced Predictions of Engine LeveL Acoustics

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University of Southampton

Description: ACAPELLA provides Rolls-Royce with aero acoustic prediction capabilities for use in multi-disciplinary optimisation design techniques. The target is to achieve a -5dB reduction cumulatively relative to the Trent XWB and Trent 1000 engines which is a step towards the interim 2035 goal on the way to the ACARE 2050 target.

Start date: 1/7/16 | **End Date:** 31/3/20

Attributes: Environment

Grant: £3.25m | **Total Cost:** £6.50m

Topic: Ultra-high Bypass Ratio Engines

113089 – ELECT

Project Title: Enhanced Low Emission Combustion Technology

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Loughborough University

Description: ELECT aims to improve lean burn system design rules and fundamental understanding. This enables significant simplifications to the current fuel system for large engine application circa 2020. Additionally this programme aims to further improve the lean burn system architecture, by incorporating the latest technologies within the control and combustion communities.

Start date: 1/2/17 | **End Date:** 31/1/20

Attributes: Environment

Grant: £7.00m | **Total Cost:** £14.00m

Topic: Advanced Core

113091 – MPP P4

Project Title: Fast Make and Design for Advanced Forming

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Manufacturing Technology Centre, University of Birmingham

Description: This project will develop technologies that will allow rapid manufacture of components for future development rig and engine tests. This project will address the development of a range of manufacturing technologies that currently have long production lead times, working in partnership and using a UK supply chain.

Start date: 1/7/16 | **End Date:** 30/6/20

Attributes: Cost

Grant: £3.46m | **Total Cost:** £6.91m

Topic: Manufacturing Processes

113093 – MPP P8

Project Title: High Performance Composites

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, National Composites Centre

Description: This project will develop competitive product capability and high manufacturing productivity for composite structures. The development of composite moulding and composite curing processes will enable cost and weight reduction on static composite components for future engines, working in partnership with and utilising the UK manufacturing services supply chain.

Start date: 1/7/16 | **End Date:** 30/6/20

Attributes: Fuel Efficiency, Cost

Grant: £3.70m | **Total Cost:** £7.40m

Topic: Manufacturing Processes

113094 – DualWallTurb

Project Title: Dual Wall Turbine Technology Development

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University of Birmingham, University Of Oxford

Description: DualWallTurb develops novel design and manufacturing technologies for high temperature materials towards advanced levels of technology readiness (MCRL4/TRL4), thereby enabling a step change in cooling flow reductions in the High Pressure Turbine (HPT). These are key enablers for ultra high bypass engines, with hotter, smaller and durable core turbine technologies.

Start date: 1/9/16 | **End Date:** 31/3/20

Attributes: Fuel Efficiency, Environment

Grant: £7.27m | **Total Cost:** £14.54m

Topic: Ultra-high Bypass Ratio Engines

113096 – HIVES

Project Title: High Integrity, Validated Engineering Space - Forge

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Advanced Forming Research Centre

All Partners: Advanced Forming Research Centre

Description: Through this project, the AFRC will create an industrially-representative experimental capability for temperature and environment controlled open and closed die hydraulic forging for UK industry. The facility will be used to perform research into metallic processing to improve component life and integrity and develop improved alloys for high-demand applications.

Start date: 1/3/17 | **End Date:** 29/2/20

Attributes: Fuel Efficiency, Environment

Grant: £6.59m | **Total Cost:** £6.59m

Topic: Manufacturing Processes

113097 – MPP P3

Project Title: Complex Fabrication Systems

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Manufacturing Technology Centre

Description: This project will develop competitive capabilities to manufacture complex, high-functionality components by advanced joining and fabrication methods. Replacement of outdated welding processes and a systems engineering based approach to structures fabrication will deliver step-change improvements in component and assembly cost, quality and supply chain productivity.

Start date: 1/7/16 | **End Date:** 30/6/20

Attributes: Fuel Efficiency, Cost

Grant: £4.80m | **Total Cost:** £9.60m

Topic: Manufacturing Processes

113098 – ANS

Project Title: Advanced Nacelle System

Value Stream: Propulsion of the Future

Time Horizon: Secure | **No. of Partners:** 5

Lead Partner: Goodrich Actuation Systems

All Partners: Goodrich Actuation Systems, National Composites Centre, Texkimp, University of Manchester, Crompton Technology Group

Description: This project seeks to develop advanced engine actuation technologies to TRL 6 to support the next generation aircraft development programmes, specifically suited to the application of Ultra High Bypass Ratio turbofans. This includes the development of adaptable actuators to minimise system complexity and advanced composite technology for strut applications.

Start date: 1/8/16 | **End Date:** 30/9/20

Attributes: Fuel Efficiency

Grant: £2.89m | **Total Cost:** £5.78m

Topic: Ultra-high Bypass Ratio Engines

113101 – ANTELOPE

Project Title: Aft Nacelle Technology Evaluation Leading to Optimised Propulsion Efficiency

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Safran Nacelles

All Partners: Safran Nacelles, Rolls-Royce

Description: ANTELOPE will develop technologies for nacelles in future engine architectures, such as Ultra-high Bypass Ratio Engines. Through this project, the consortium will examine technologies aiming to reduce fuel burn from an optimised integrated powerplant system, through examining topics impacting weight and drag.

Start date: 1/8/16 | **End Date:** 31/7/18

Attributes: Fuel Efficiency

Grant: £2.61m | **Total Cost:** £5.21m

Topic: Ultra-high Bypass Ratio Engines

113105 – IPCRESS

Project Title: Intermediate Pressure Compressor Realisation for Enhanced Sub-System

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University of Cambridge, University Of Oxford

Description: IPCRESS will develop competitive capability for gas turbine compressors. The development of an intermediate pressure compressor that integrates around a power gearbox will enable Rolls-Royce to demonstrate its new UltraFan™ engine architecture which represents an step in continuing to meet environmental targets and will result in more competitive future engines.

Start date: 1/1/17 | **End Date:** 31/12/20

Attributes: Fuel Efficiency

Grant: £6.52m | **Total Cost:** £13.04m

Topic: Ultra-high Bypass Ratio Engines

113106 – DELICE

Project Title: Design of Engineered Lightweight Innovative Casings for Engines

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, National Composites Centre, University Of Oxford

Description: A fundamental enabler for the new UltraFan™ architecture is the development of a large diameter, low speed, low pressure ratio fan system. This project will result in the design and manufacture of the world's largest composite fan case in support of the UltraFan™ demonstrator programme.

Start date: 1/12/16 | **End Date:** 30/6/20

Attributes: Fuel Efficiency, Cost

Grant: £5.95m | **Total Cost:** £11.91m

Topic: Ultra-high Bypass Ratio Engines

113107 – PIPS

Project Title: Powerplant Integration with Platform Systems

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Cranfield University, Queen's University Belfast, University Of Oxford

Description: The Power-Plant Integration with Platform Systems (PIPS) program develops technologies in the UK to enable greater integration between the Power-plant and Airframe, resulting in a more capable and efficient aircraft. This programme develops facilities and skills in the UK to maintain and grow our integration capability.

Start date: 1/12/16 | **End Date:** 31/3/20

Attributes: Fuel Efficiency

Grant: £4.45m | **Total Cost:** £8.91m

Topic: Multi-physics, Multi-fidelity Modelling

113110 – CHASM

Project Title: Capitalising Heuristic Advanced Sub-system Maturation

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, National Composites Centre

Description: This project delivers the design and manufacture of components including fan disc, fan Output Guide Veins (OGV), Engine Support Structures (ESS) and Oil Tank to integrate into a Ultra-High Bypass Ratio (UHBR) engine. Each component presents its own unique design and manufacturing challenges that need to be overcome, for the engine architecture to be competitive in the large civil gas turbine

Start date: 1/12/16 | **End Date:** 29/2/20

Attributes: Fuel Efficiency, Cost

Grant: £8.13m | **Total Cost:** £16.26m

Topic: Ultra-high Bypass Ratio Engines

113118 – AutoProStruct

Project Title: Automated Technologies for the Manufacture of Composite Propulsion and Aero-Structures

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: National Composites Centre

All Partners: National Composites Centre

Description: This investment is focussed around the acquisition of advanced composites production technologies, supporting the manufacture of future propulsion and aerostructures components. The project will establish advanced automated manufacturing and inspection capabilities at the NCC to develop and validate suitable autoclave and out-of-autoclave technologies for next generation aerospace products.

Start date: 1/6/17 | **End Date:** 30/11/19

Attributes: Cost

Grant: £9.84m | **Total Cost:** £9.84m

Topic: Manufacturing Processes

113119 – Osney

Project Title: Infrastructure Investment for the University of Oxford Osney Thermo-fluids Laboratory

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: University Of Oxford

All Partners: University Of Oxford

Description: This project will look to achieve a step change in capability at the Osney Thermofluids Laboratory to measure and research cooling performance and hot stage technologies essential for the operation of high pressure turbine stages of large engines, providing greater accuracy to measure metal temperature of turbine blades and vanes.

Start date: 1/2/18 | **End Date:** 31/1/22

Attributes: Fuel Efficiency, Cost

Grant: £6.13m | **Total Cost:** £6.13m

Topic: Infrastructure

113120 – POSTIE

Project Title: Physical Optimisation of Structural Topology for Integrating Engines

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Altair Engineering

Description: POSTIE is developing a weight-optimised structural solution for the Rolls-Royce UltraFan™ geared aero engine. It is investigating the potential added benefits of topology optimisation. POSTIE is led by Rolls-Royce in partnership with Altair. The project will also strengthen the UK Fast Make supply chain for aircraft demonstrator engines.

Start date: 1/4/17 | **End Date:** 31/3/20

Attributes: Fuel Efficiency, Cost

Grant: £9.00m | **Total Cost:** £18.00m

Topic: Ultra-high Bypass Ratio Engines

113121 – SUSSUDIO

Project Title: System Understanding & Sub-System Utopia through Design Integration & Optimisation

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce

Description: This project develops the detailed design of an Ultra-high Bypass Ratio (UHBR) aero gas turbine engine demonstrator, which will be used to verify advanced technologies at a whole system level. The project aims to prove the feasibility of the demonstrator and sufficiently reduce the risks to allow the full launch of manufacture of the demonstrator vehicle.

Start date: 1/7/17 | **End Date:** 30/6/18

Attributes: Fuel Efficiency

Grant: £9.76m | **Total Cost:** £19.53m

Topic: Ultra-high Bypass Ratio Engines

113122 – COAST

Project Title: Critical Oil and Air System Technologies

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Bladon Jets, University of Nottingham, University Of Oxford

Description: COAST looks at maturing the readiness level of a range of engine technologies including advanced seals for gas turbines application, cabin blower and modelling of oil flows and heat transfer in gas turbines bearing chambers through architecture concept studies, rig testing, modelling work and development of designs suitable for engine demonstrator testing.

Start date: 1/4/17 | **End Date:** 31/3/20

Attributes: Fuel Efficiency, Cost, Passenger Experience

Grant: £3.71m | **Total Cost:** £7.42m

Topic: Ultra-high Bypass Ratio Engines

113132 – DigiProp

Project Title: Digital Propulsion

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: GE Aviation Systems

All Partners: GE Aviation Systems, Advanced Manufacturing Research Centre, Manufacturing Technology Centre, National Composites Centre

Description: Digital Propulsion utilises up-to-date design and manufacturing methods for turboprop aircraft. Futuristic blade design along with improved lighter control systems contribute toward noise and fuel savings. Advanced manufacturing technology will increase production while reducing cost. All work packages embed the Digital Thread - a web of data for manufacturing, health record and operator logs.

Start date: 1/6/17 | **End Date:** 31/5/20

Attributes: Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility, Passenger Experience

Grant: £9.95m | **Total Cost:** £20.22m

Topic: Multi-physics, Multi-fidelity Modelling

113140 – NTProStruct

Project Title: Novel Technologies for Propeller and Aero-Structure Manufacturing

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: National Composites Centre

All Partners: National Composites Centre

Description: This investment is focused around the acquisition of advanced composites production technologies, supporting the manufacture of future propeller and aerostructures components. The project will establish novel manufacturing capabilities at the NCC to develop and validate suitable autoclave and out-of-autoclave technologies for the manufacture of next generation aerospace products.

Start date: 1/8/17 | **End Date:** 31/1/19

Attributes: Cost

Grant: £2.17m | **Total Cost:** £2.17m

Topic: Manufacturing Processes

113142 – UHBR Thermals

Project Title: Ultra High Bypass Ratio Thermals

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 6

Lead Partner: Meggitt Aerospace

All Partners: Meggitt Aerospace, Advanced Forming Research Centre, Advanced Manufacturing Research Centre, Cranfield University, Manufacturing Technology Centre, S&C Thermofluids

Description: Technology changes for next-generation UHBR turbofan engines results in a larger oil heat load to be managed, with less space available to mount the equipment and increasing amounts of heat to be managed using air. UHBR Thermals develops new thermal management technologies and manufacturing techniques to increase the competitiveness of the UK's supply chain.

Start date: 1/9/17 | **End Date:** 31/8/20

Attributes: Fuel Efficiency, Environment, Cost

Grant: £3.73m | **Total Cost:** £7.46m

Topic: Ultra-high Bypass Ratio Engines

113144 – PACE

Project Title: Proving Advanced Concept Engine

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce

Description: This project is aimed at providing Rolls-Royce with the necessary advanced X-ray capability and tooling to validate the next generation of large diameter, geared architecture engines. Rolls-Royce will deliver key capabilities into their indoor test bed facilities in Derby, including X-ray, image analysis and tooling for engine assembly.

Start date: 1/4/18 | **End Date:** 30/9/22

Attributes: Safety, Fuel Efficiency

Grant: £6.36m | **Total Cost:** £22.65m

Topic: Infrastructure

113156 – CAJORR

Project Title: Cutting edge Approaches for Joining of RR1073

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Swansea University, University of Birmingham

Description: Rolls-Royce is developing a new high-temperature nickel alloy, able to operate at higher speeds and temperatures, while delivering an acceptable service life. Joining of these new materials is an important aspect to maximise flexibility in exploitation. This project accelerates development of joining technologies to enable these superalloys to be utilised in engine designs.

Start date: 1/2/18 | **End Date:** 31/1/22

Attributes: Fuel Efficiency, Cost

Grant: £4.06m | **Total Cost:** £8.12m

Topic: Ultra-high Bypass Ratio Engines

113157 – DRAMA

Project Title: Digitised Reconfigurable Additive Manufacturing facilities for Aerospace

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 9

Lead Partner: Manufacturing Technology Centre

All Partners: Manufacturing Technology Centre, Applied Tech Systems, Autodesk, Granta Design, Manufacturing Technology Centre, Midlands Aersopace Alliance, National Physical Laboratory, Renishaw, University of Birmingham

Description: This project will deliver a world first digitally twinned reconfigurable additive manufacturing (AM) facility which will be at the forefront of AM technology, for use by UK enterprises across the full supply chain to their needs and provide an effective validation platform for industry users of digital AM processes.

Start date: 1/11/17 | **End Date:** 31/10/20

Attributes: Fuel Efficiency, Cost

Grant: £11.17m | **Total Cost:** £14.34m

Topic: Additive Manufacture

113158 – EXCITE

Project Title: EXternal Component Integration of Technologies for Engines

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University Of Oxford, University of Birmingham, National Composites Centre

Description: EXCITE addresses the design challenges for the Externals Sub-System associated with the change to UltraFan™ engine architecture. This enables realisation of the Externals Sub-System and component definitions for the UltraFan™ demonstrator, delivering a TRL6 level for the product and demonstrating the enabling sub-system technology to support a product entry into service in 2025.

Start date: 1/1/18 | **End Date:** 31/12/20

Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £4.64m | **Total Cost:** £9.34m

Topic: Ultra-high Bypass Ratio Engines

113160 – CEMTEC

Project Title: Ceramic Matrix Technology Development

Value Stream: Propulsion of the Future

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University Of Oxford, Swansea University, National Composites Centre

Description: An enabler for a new engine architecture is the development of SiC-SiC ceramic matrix composite (CMC) technology. This enhances the competitive position of future civil large engine products. The introduction of CMC turbine components offer significant benefits to Specific Fuel Consumption, along with weight reduction, increased cyclic life and reduced component manufacturing lead times.

Start date: 1/3/18 | **End Date:** 28/2/21

Attributes: Fuel Efficiency, Environment, Cost

Grant: £7.80m | **Total Cost:** £15.60m

Topic: Ultra-high Bypass Ratio Engines

SMART, CONNECTED AND MORE ELECTRIC AIRCRAFT

This theme encompasses a range of complex aircraft systems provided by UK businesses, specifically the technologies, tools, processes and facilities needed to develop and produce them.

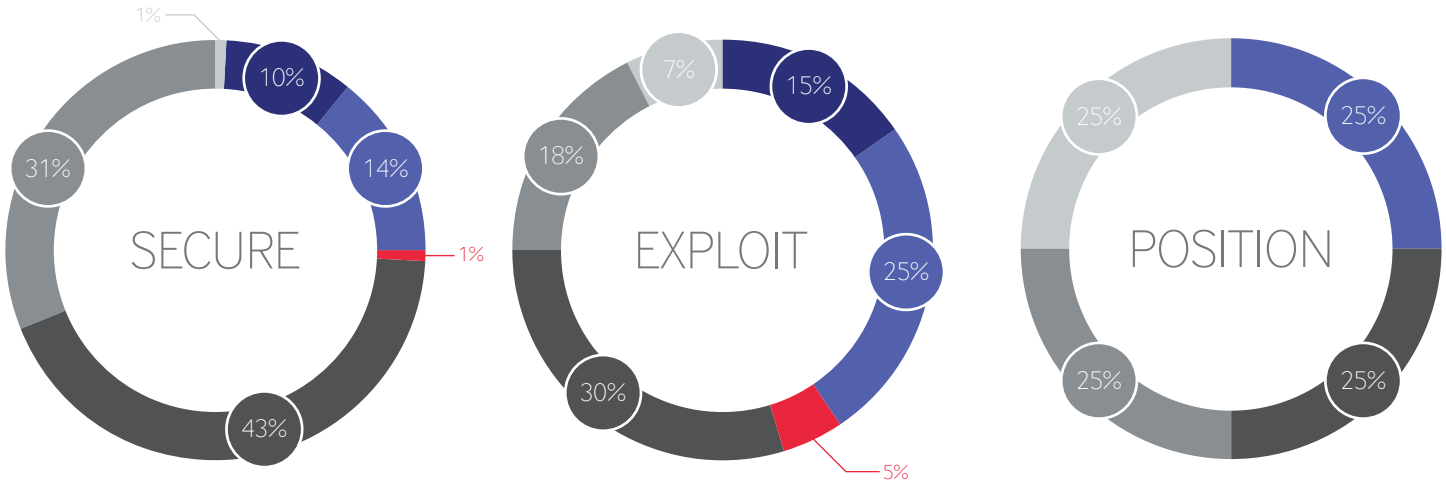
Development and manufacture of advanced systems represents more than 15% of the UK aerospace sector's direct economic activity, concentrated in wide and narrow-body passenger aircraft and business jets. The UK is a world leader in landing gear, power generation, power conversion and distribution, electrical actuation, digitally enhanced communications and next-generation flight deck technologies. These are fundamental to improving fuel burn, emissions, operational capability, passenger experience, lifecycle cost and safety. In the future, systems are expected to constitute a greater share of an aircraft's value.

Embedded sensors, novel displays and software are making aircraft more intelligent, leading to improved platform availability, reduced crew workload and an overall enhancement of aircraft safety. These technologies will also be one of the key prerequisites to enable unmanned air vehicles to access controlled airspace. Adoption of electrical power systems will reduce weight and cost and enhance reliability. Beyond 2030, new propulsion architectures will require disruptive electrical power system technology.

The Smart, Connected and More Electric Aircraft theme in summary is:

- Enabling introduction of more electric systems and advanced electrical power systems to support hybrid and electric propulsion
- Developing secure digital systems and communications
- Securing capabilities in fuel, landing gear and energy management systems

Safety	Fuel Efficiency	Environment	Cost	Operational Needs & Flexibility	Passenger Experience	Totals
£42.43m	£69.93m	£10.62m	£105.22m	£68.28m	£19.14m	£315.62m



101796 – IVHM-EVOLVE	
Project Title: Ecosystem of Intelligent Self-Organising Sensor Nodes for Helicopter Health Monitoring	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Exploit	**No. of Partners:** 4
Lead Partner: Helitune	
All Partners: Helitune, National Composites Centre, Queen Mary University of London, XMOS	
Start date: 1/8/14	**End Date:** 28/2/18
Attributes: Cost, Operational Needs & Flexibility	
Grant: £1.77m	**Total Cost:** £2.58m
Topic: Through-life	

The project aims to develop and produce a distributed sensor network for helicopter health monitoring – enhancing Integrated Vehicle Health Management (IVHM) for small- and medium-sized helicopters engaged in applications including oil & gas and law enforcement. The outcome of the project is to reduce the weight and cost of current systems by around 20%, through the application of innovative UK-developed technologies, focusing on the miniaturisation of distributed sensors with processing nodes positioned all over the aircraft.

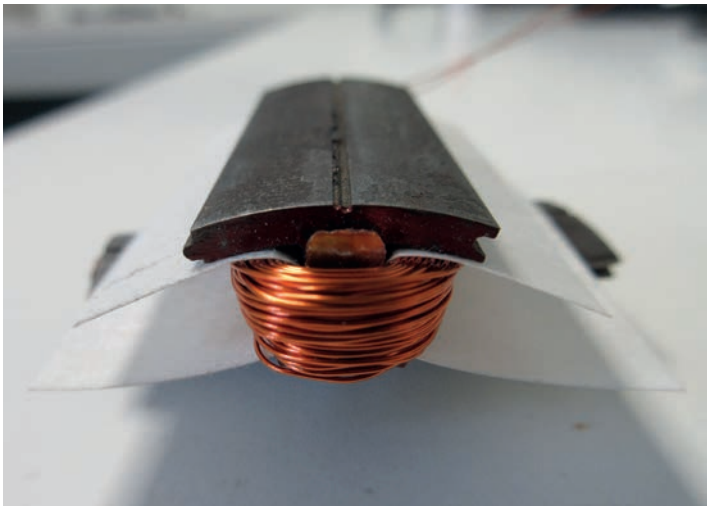
The product will use intelligent, self-organising sensor nodes, able to adapt and prioritise the system around the current health of the aircraft. "The resulting product would reduce the size of the system from something akin to a standard shoebox to the size of a couple of Lego bricks" said Peter Morrish, Technology & Support Manager at Helitune. "By splitting the sensors and systems, and distributing them around the aircraft, we can optimise the coverage while maintaining most of the functionality". The consortium will also investigate the future exploitation of its technology to other areas, including fixed-wing aircraft, unmanned aircraft vehicles, automotive and new markets such as industrial power and renewables.

101797 – MORPHEUS	
Project Title: Monitoring Pump Health Using Optical Sensors	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Exploit	**No. of Partners:** 2
Lead Partner: Oxsensis	
All Partners: Oxsensis, Parker Hannifin Manufacturing	
Start date: 7/1/2014	**End Date:** 30/6/2018
Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility	
Grant: £1.22m	**Total Cost:** £2.37m
Topic: More Electric Aircraft	

MORPHEUS developed novel optical sensors for monitoring aircraft fuel system equipment by the measurement of fuel pressure, flow, pump shaft speed and continuous valve position indication. Non-electrical sensors have the benefits of Electro-Magnetic Interference immunity in an increasing electrically actuated environment and being intrinsically safe. The project has successfully demonstrated the application of optical sensors for the measurement of Valve position, Fuel Pump pressure and Fuel Pump shaft speed. By focusing after initial customer feedback, the project has delivered TRL4/5 pump pressure indication equipment, which is now ready to be bid into flight applications.

Discussions are now in progress with an airframe OEM to allow fuel system rig test of MORPHEUS pressure switches to evaluate performance and reliability, both for new build and for drop-in replacement or retrofit into existing aircraft programmes. The product is expected to reduce fuel system and wing assembly costs, by simplification of installation. The value of the product could be $50m - $100m, based on potential volumes on new civil large platform applications. MORPHEUS has created at least one job and is part of protecting the overall 25 strong Oxsensis workforce. Spillover effects include building Oxsensis credibility in other supply chains e.g. land-based gas turbines for power generation.

102374 – HARAS	
Project Title: High Availability Redundant Actuation Systems	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Exploit	**No. of Partners:** 3
Lead Partner: Triumph Actuation Systems	
All Partners: Triumph Actuation Systems, Kugel Motion, NEMA	
Start date: 1/11/15	**End Date:** 31/10/18
Attributes: Fuel Efficiency, Operational Needs & Flexibility	
Grant: £0.51m	**Total Cost:** £1.01m
Topic: More Electric Aircraft	



The HARAS project addresses five topics, encompassing areas of technology for a more electric aircraft, and specifically targets unmanned vehicles and their electrical actuation systems. A key objective of the program was to develop high availability, fault tolerant electrical actuation solutions suited to emerging Unmanned Vehicle Aircraft (UAV) and similar next generation platforms. The global actuator market is expected to reach $3,800 million by 2019, and European commercial aviation actuator system market to $1,600 million.

The system architecture was completed to set weight, size and performance requirements ensuring future relevance. Advanced motors were developed using brushless permanent magnet, segmented lamination and PEEK (Poly-Ether Ether Ketone) slot liner technology, progressed to TRL6. Also developed was the design and topology of a multi-structure, high availability electro-mechanical actuator (EMA), including gearbox and/or screw components - both rotary and linear actuators were evaluated. In addition, a high availability actuator control unit is being developed and currently at concept level (PDR), along with the EMA actuator. HARAS has focussed on developing the technology for a specific problem, associated with narrow space constraints for control surface actuation, as well as increasing redundancy and therefore aircraft utilization.

110127 – ALWRT	
Project Title: Aircraft Lightweight Radial Tyre	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Secure	**No. of Partners:** 2
Lead Partner: Dunlop Aircraft Tyres	
All Partners: Dunlop Aircraft Tyres, Airbus Operations	
Start date: 1/4/12	**End Date:** 30/9/16
Attributes: Cost	
Grant: £5.91m	**Total Cost:** £10.95m
Topic: Advanced Landing Gear Systems	

The ALWRT project aimed to develop and test next-generation aircraft tyres that are lighter and more robust. Dunlop collaborated with Airbus to develop main-wheel radial tyres for the current and latest neo versions of the A320 family of aircraft. The project's key objectives were to develop new technologies for the design of next-generation aircraft radial tyres, new manufacturing processes for radial tyres, and new materials; to develop a finite element analysis (FEA) modelling capability; to test and qualify an A320 main landing gear radial tyre to the Airbus specification; and to integrate the tyre with wheel/brake and aircraft systems.

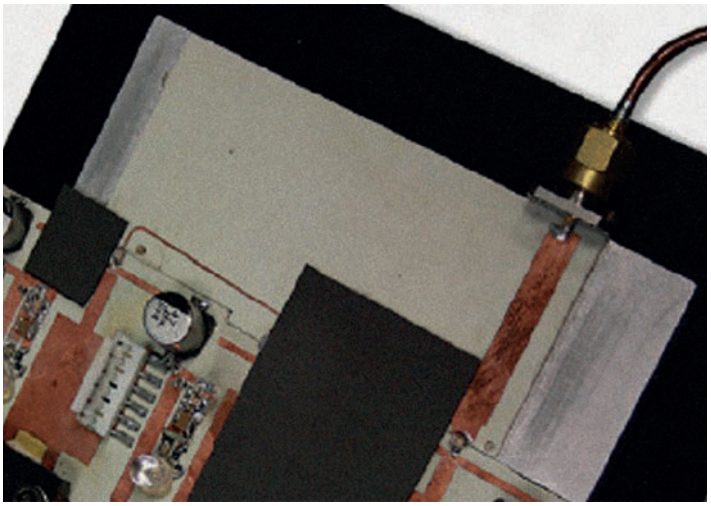
Dunlop is currently proceeding on a commercial basis with Airbus to certify and approve the radial aircraft tyres for the Airbus A320 main landing gear. Dunlop's innovation with materials demonstrated an improved strength-to-weight ratio, enhanced resistance to foreign object damage and increased landings per tread life. As a result of the project, Dunlop developed the next generation of aircraft radial tyres, increased tyre performance by 100% and matured the technology to TRL6 ready for commercial application. Ian Edmondson, the company's executive chairman, said, "This grant signals the UK Government's commitment to helping smaller businesses to prosper in the global aerospace industry."

113020 – LAGEMOSYS	
Project Title: LAnding GEar MOnitoring SYStems	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Secure	**No. of Partners:** 3
Lead Partner: Safran Landing Systems	
All Partners: Safran Landing Systems, Advanced Manufacturing Research Centre, University of Cambridge	
Start date: 1/7/14	**End Date:** 31/3/18
Attributes: Cost, Operational Needs & Flexibility	
Grant: £1.98m	**Total Cost:** £3.30m
Topic: Through-life	

The LAGEMOSYS project focused on how health and usage monitoring for aircraft landing gears could reduce unscheduled maintenance, increase airline operational efficiency and enhance the design of future landing gears. It aimed to develop an operational loads monitoring system, obtaining data to support product optimisation; understand the certification requirements and their impact on installing a health monitoring system on to a revenue aircraft; and better understand the landing gear operational environment.

The project looked to develop self-learning mathematical modelling techniques that can reliably predict a range of aircraft parameters on a landing gear using aircraft flight data with minimal additional sensors. Through simulation work, the project identified the key 8-10 parameters that are critical to understanding the main performance characteristics for the landing gear and being able to accurately assess abnormal events that occur in service. "If we had placed sensors to measure all aspects of the landing gear performance, that would have doubled the cost of the landing gear system", said Kyle Schmidt, Vice President of Product Development, R&T Engineering at Safran Landing Systems. "This project has allowed us to think more strategically about this and to start exploring the potential service model offering that might arise from it."

113029 – HARNet	
Project Title: Harmonised Antennas, Radios, and Networks	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Secure	**No. of Partners:** 5
Lead Partner: Thales	
All Partners: Thales, Cobham, Queen Mary University of London, University of Bradford, University of Southampton	
Start date: 1/10/13	**End Date:** 31/12/15
Attributes: Safety, Cost	
Grant: £6.43m	**Total Cost:** £11.59m
Topic: Smart Systems	



There is an increasing demand for on-board aircraft connectivity – driven by future air traffic management requirements, and also by airline and passenger needs for enhanced in-flight connectivity. Until now, introducing new communications technology to aircraft has meant adding additional equipment to existing systems. HARNet has instead focused on a radically different way of approaching communications: integrated modular communications. Key benefits include a reduction in operational capacity constraints, higher reliability and security, fewer aircraft equipment needs, freeing up critical space within the aircraft, reducing weight and using less power.

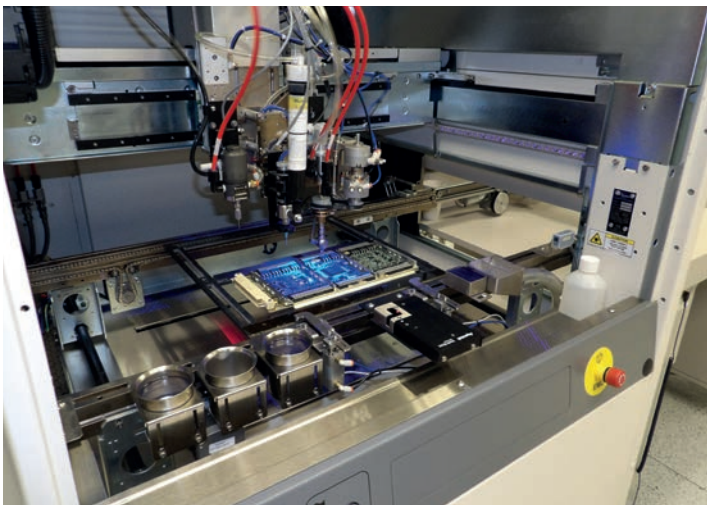
The research was completed successfully in December 2015 and has led to the development of intellectual property and two patents. The prototypes developed will inform the work now required to mature the Thales Integrated Modular Communications concept. "Collaboration with the consortium members provided valuable momentum throughout the project. Thales and Cobham held invaluable technical workshops with the respective academic partners who were all instrumental in the progression and shaping of the technical output", said Caroline Quill, Head of Product Development at Thales UK.

113031 – HVCMS	
Project Title: High Volume Composite Manufacture for Fuel Pipe Technology	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Exploit	**No. of Partners:** 2
Lead Partner: Crompton Technology Group	
All Partners: Crompton Technology Group, Advanced Manufacturing Research Centre	
Start date: 1/9/14	**End Date:** 31/8/17
Attributes: Cost	
Grant: £2.26m	**Total Cost:** £3.47m
Topic: Manufacturing Processes	

The HVCMS project set out to answer the question of how to produce composite fuel pipes at peak production rates of 5,000 pipes per month. Filament-wound composite pipes are used in aircraft fuel and hydraulic systems to manage the effect of a lightning strike. UTAS has developed a robust method of joining the composite tube/pipe with various metal fittings.

The project aimed to mature manufacturing technologies and automate production systems to manufacture 50,000 fuel pipes a year. It sought to optimize the composite filament winding process in support of HVCMS and for applications where higher production rates are required; the project improved filament winding performance by 20%. It also demonstrated manufacturing technologies for complex geometry composite fuel pipes, enabling further application of fuel pipe technology. HVCMS has developed a composite manufacturing automation capability that can demonstrate UTAS's ability to deliver at significant programme rates, meeting key customer metrics, and has secured 30 highly-skilled engineering roles within its Banbury Composite Centre of Excellence. Dave Chard, UTAS's Business Development Director, said, "The development of these technologies has enabled UTAS Banbury to demonstrate that it is able to support high-rate composite manufacturing requirements, and also open up opportunities that UTAS is now investigating."

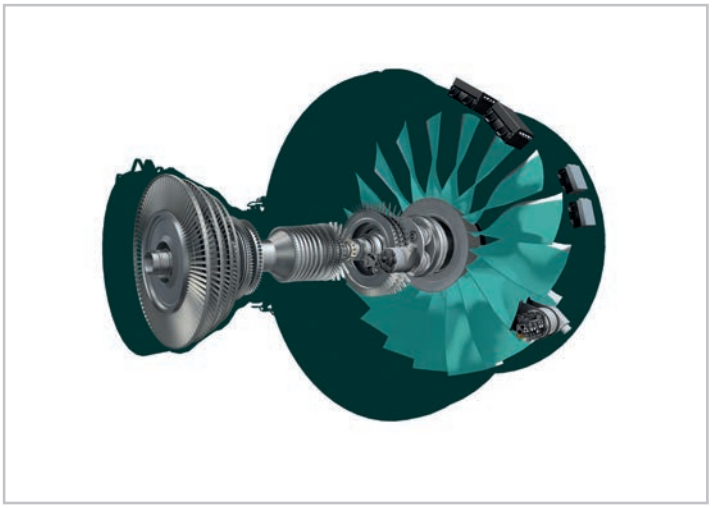
113032 – AMCA	
Project Title: Advanced Manufacturing for Complex Avionics	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Secure	**No. of Partners:** 5
Lead Partner: GE Aviation Systems	
All Partners: GE Aviation Systems, Manufacturing Technology Centre, Omega Engineering , Speciality Coating Systems, Tannlin	
Start date: 1/4/14	**End Date:** 31/8/17
Attributes: Cost, Operational Needs & Flexibility	
Grant: £3.83m	**Total Cost:** £6.41m
Topic: Manufacturing Processes	



The next generation digital and "all electric aircraft" will require increasingly capable, complex and affordable avionics systems to operate in increasingly harsh environments. To meet this challenge and be competitive in the world market, avionics equipment manufacturers must leverage new technologies in their designs and manufacturing processes. This project has brought together a UK supply chain in a collaborative consortium, to undertake research which will enhance the UK ability to manufacture certifiable complex avionics for future aerospace systems.

The project researched new technologies to enhance the design and manufacture of new and existing product ranges with a particular focus on a new Remote Electronics Unit (REU), that had significant design and manufacturing challenges. There is a need to make the printed circuit board (PCB) significantly smaller, capable of operating in harsher environments while maintaining certification, this drives complexity and the need to adopt new electronic component technologies in the design. Manufacturing capability must be developed to enable the manufacture of complex PCBs for high value, low volume high mix applications against increasing pressure to outsource assembly operations. GE Aviation, as a leader in safety critical aerospace product design and manufacture, led the project consortium from the manufacturing supply chain .

113033 – IPPA	
Project Title: Integrated Power & Propulsion Architectures	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Position	**No. of Partners:** 7
Lead Partner: Airbus Group	
All Partners: Airbus Group, GE Aviation Systems, Honeywell Aerospace, Raytheon Systems, Rolls-Royce, Safran Electrical & Power, Goodrich Control Systems	
Start date: 1/7/14	**End Date:** 31/3/17
Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility, Passenger Experience	
Grant: £4.17m	**Total Cost:** £8.34m
Topic: More Electric Aircraft	

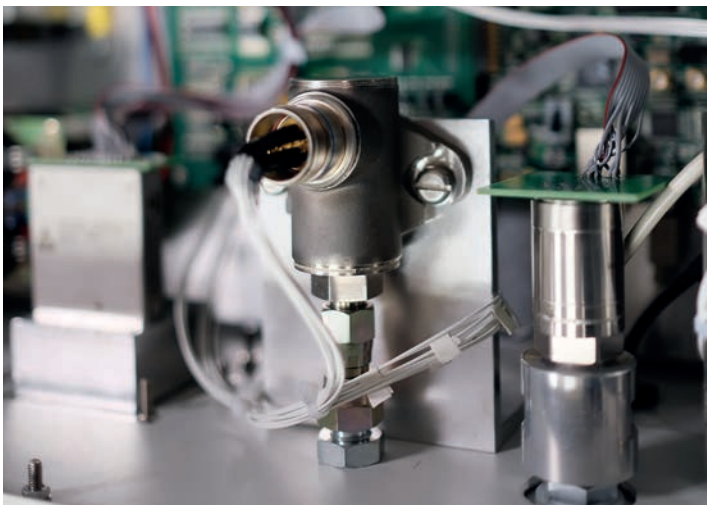


The large transport aircraft industry has been introducing more electrical systems to replace the traditional hydraulic, bleed air and mechanical systems in order to reduce fuel burn. The objective of this project is to identify the key propulsion, power generation, distribution and management technologies that will enable a more electric aircraft to achieve fuel burn benefit in the range of 3-6%.

The project modelled and evaluated an integrated propulsion and electrical power architecture, from engine to electrical loads – with the aim of quantifying benefits and identifying and developing the system-level enablers. It brought together the suppliers of all the elements of the architecture, engine, generation, distribution and electrical loads with the airframe integrator.

Partners performed design iterations and optimization, improving their systems' key performance indicators such as weight, cost, fuel burn, peak power or total energy required. Some key performance indicators have been improved by as much as 30%. Werner Rothammer, Head of the More Electric Aircraft Programme at Airbus, said, "The project contributed to an increased visibility of the UK supply chain that is now in a position to be more credible and competitive suppliers to future Airbus programmes. This would not have been possible without ATI support."

113035 – HEEDS	
Project Title: Harsh Environment Electronic Device Systems	
Value Stream: Smart, Connected and More Electric Aircraft	
Time Horizon: Exploit	**No. of Partners:** 6
Lead Partner: Rolls-Royce	
All Partners: Rolls-Royce, BAE Systems, Cobham, GE Aviation Systems, Manufacturing Technology Centre, Raytheon Systems	
Start date: 1/4/14	**End Date:** 31/3/18
Attributes: Safety, Cost, Operational Needs & Flexibility	
Grant: £4.47m	**Total Cost:** £7.79m
Topic: More Electric Aircraft	



The HEEDS project aims to develop electronic equipment that can operate in harsh environments across industries. The equipment must perform at temperatures of up to 250°C compared to the current 95°C.

Developing this technology will enable Rolls-Royce to move electronic equipment from the engine fan case to the core as part of the Advance and UltraFan™ engine programmes. This will create savings in terms of cost, weight and build time by reducing the need for complex pipework. The project focuses on a number of areas including pressure sensors, soldering technologies and Near Field Communication (NFC) memory units, as used in contactless debit cards.

The Rolls-Royce element of the HEEDS project will be based at the new £75m Rolls-Royce facility in Solihull, which designs, develops, manufactures and tests technologies. Such technology will have benefits in other industries such as oil and gas and submarines, where similar requirements exist.

"Experiences and lessons learned are shared amongst HEEDS partners thereby enabling others to benefit and potentially avoid costly errors or dead-ends," said Paul Moses, Project Manager at Cobham.

101371 – ALGAAP

Project Title: Advanced Landing Gear Aero-loads and Aero-noise Prediction

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, University of Southampton

Description: This project focuses on aero-loads and noise prediction for landing gear and doors. Aero-loads analysis has been developed and tested on a 1/10th scale aircraft model including detailed models of main and nose landing gears. The project has also developed high precision Computational Fluid Dynamics (CFD) landing-gear aero-loads and noise-prediction codes.

Start date: 1/12/12 | **End Date:** 30/11/15

Attributes: Fuel Efficiency, Environment

Grant: £0.62m | **Total Cost:** £1.24m

Topic: Advanced Landing Gear Systems

101795 – AEMTA

Project Title: Advanced Electrical Machines Technologies for Aircraft

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 7

Lead Partner: Safran Electrical & Power

All Partners: Safran Electrical & Power, Arnold Magnetic Technologies, FGP Precision Engineering , MEP, Midland Tool & Design, Newcastle University, Teesside University

Description: AEMTA targets a doubling in high-temperature performance of electro-mechanical systems operating in harsh environments, to 250oC–280oC, necessary for moving electrical motors and machines closer to the engine core. The electromechanical systems will provide further performance benefits, including reducing component weight and volume and increased robustness against the effects of vibration.

Start date: 1/5/14 | **End Date:** 30/4/17

Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £3.08m | **Total Cost:** £5.47m

Topic: More Electric Aircraft

101802 – EMMAS

Project Title: Electro-Mechanical Magnetic Actuator Systems

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Triumph Actuation Systems

All Partners: Triumph Actuation Systems, Advanced Manufacturing Research Centre, Magnomatics, Romax Technology

Description: EMMAS aims to create safer, quieter, more-reliable electro-mechanical actuators, developing a weight and cost neutral product solution (compared to hydraulic solutions). The new actuators are vibration resilient, require less maintenance, are resistant to 'jamming' when overloaded, and can operate reliably in severe environments (-55°C to 85°C).

Start date: 1/6/14 | **End Date:** 31/8/18

Attributes: Safety, Cost, Operational Needs & Flexibility, Passenger Experience

Grant: £1.56m | **Total Cost:** £2.53m

Topic: More Electric Aircraft

102363 – SREEV

Project Title: SPARCS Rotary Engine for Electric VTOLs

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Advanced Innovative Engineering

All Partners: Advanced Innovative Engineering, Electronica Products, McGeoch Technology, Vortex Exhaust Technology

Description: The SREEV project is developing a hybrid power unit for UAVs, delivered by four UK based SMEs. The project will couple an Internal combustion engine with a hybrid power system in order to reap the benefits that this can provide, including extending flight range, reducing fuel burn and improving flight acoustics.

Start date: 1/12/15 | **End Date:** 31/5/18

Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £0.53m | **Total Cost:** £1.06m

Topic: Unmanned Aerial Systems

102365 – AQUILA

Project Title: Secure and Robust Communication System for Avionics Operations and Acquisition of Payload Data for Remote Piloted Aircraft

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Avanti Communications

All Partners: Avanti Communications, Barnard Microsystems, Nottingham Scientific, Viasat

Description: AQUILA is addressing a new lightweight and high capacity communication system, improving security and robustness. Designed for the low cost Remote Piloted Aircraft (RPA) market. It proposed new protocols for wireless enabled systems and connectivity for in-flight operations acquisition of aircraft data, improving safety related systems and reliability of RPA auto-pilot for operations.

Start date: 1/12/15 | **End Date:** 31/8/18

Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £2.08m | **Total Cost:** £4.15m

Topic: Unmanned Aerial Systems

102371 – DBAHX

Project Title: Diffusion Bonded Aero Heat Exchanger

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 6

Lead Partner: Meggitt Aerospace

All Partners: Meggitt Aerospace, Meggitt Aerospace, Precision Micro, S&C Thermofluids, The Open University, Vacuum Furnace Engineering

Description: The Diffusion Bonded Aero Heat Exchanger project brings new technology to heat exchangers suitable for Ultra High Bypass Ratio aircraft engines. This develops the technologies required to conduct deep chemical etching of aluminium alloy plates, and to solid-state diffusion bond the etched plates to produce a novel heat exchanger.

Start date: 1/10/15 | **End Date:** 31/3/18

Attributes: Fuel Efficiency

Grant: £0.39m | **Total Cost:** £0.87m

Topic: Advanced Core

102372 – LLFPC

Project Title: Lightweight Long Flexible Printed Circuits For Aerospace Applications

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Secure | **No. of Partners:** 5

Lead Partner: GKN Aerospace

All Partners: GKN Aerospace , Axon Cable, Manufacturing Technology Centre, Trackwise Designs, Tyco Electronics

Description: The objectives of LLFPC are to demonstrate the feasibility of using novel, lightweight, long-length, flexible printed circuitry to replace traditional wire and cable in aerospace applications and to demonstrate a cost-effective reel-to reel manufacturing process for a system solution. The consortium brings together 4 industrial partners alongside the MTC.

Start date: 1/10/15 | **End Date:** 30/6/18

Attributes: Safety, Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £0.94m | **Total Cost:** £1.53m

Topic: More Electric Aircraft

110065 – ELG

Project Title: Electric Landing Gear

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Safran Landing Systems

Description: The Electric Landing Gear project applies new electric actuation systems for braking, steering and extension/retraction in place of existing hydraulic systems to challenging landing gear environment. The key objective being to minimise maintenance, increase availability and reduce the cost of landing gear ownership.

Start date: 1/4/11 | **End Date:** 31/3/14

Attributes: Cost, Operational Needs & Flexibility

Grant: £2.32m | **Total Cost:** £4.65m

Topic: More Electric Aircraft

110066 – AGILE-CREST

Project Title: Advanced Ground operations through Landing Gear Enhancements and The Corrosion Resistant Steel

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Secure | **No. of Partners:** 2

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Safran Landing Systems

Description: This project applies new high strength stainless steel materials to the challenging Landing Gear environment with the key objective to minimise corrosion related maintenance and enable greatly extended Time between overhaul (TBO). Corrosion contributes to operational interrupts, flight cancellations and is one of the major contributors to the maintenance of Landing Gear.

Start date: 1/4/11 | **End Date:** 31/3/14

Attributes: Cost, Operational Needs & Flexibility

Grant: £5.89m | **Total Cost:** £11.78m

Topic: Through-life

110115 – SILOET 2 P1

Project Title: Holistic Optimising Systems

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Raytheon Systems

Description: The project aims to develop a range of gas turbine control technologies, that operate as a system to optimise engine performance. These technologies are expected to improve fuel consumption and in-service reliability. The project scope includes sub-system design, modelling and demonstration in appropriate test vehicles.

Start date: 1/1/13 | **End Date:** 31/12/16

Attributes: Fuel Efficiency

Grant: £3.75m | **Total Cost:** £7.50m

Topic: Smart Systems

113004 – FFD

Project Title: Future Flight Deck Technology

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: GE Aviation Systems

All Partners: GE Aviation Systems, BAE Systems, Coventry University, University of Southampton

Description: The project developed a new flight deck concept to improve pilot situational awareness, incorporating advanced technologies into cockpit displays, data networks, graphics and video processing; including touch screens and head-up display technologies. TRL 5-6 has been demonstrated with power and weight reductions of up to 30% being achieved, safeguarding around 50 UK jobs.

Start date: 1/10/13 | **End Date:** 31/12/16

Attributes: Safety, Operational Needs & Flexibility

Grant: £5.91m | **Total Cost:** £10.95m

Topic: Smart Systems

113008 – SILOET 2 P16

Project Title: Future Novel Control and Monitoring

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce

Description: Developing advanced fuel system technologies. Specifically, novel actuators to accommodate higher duty & fit to an ever-shrinking engine envelope. A step change in fuel pumping as a result of higher duty, flow rate, efficiency and reliability. Development of power electronics and electric machines for electric pumps. Finally, to examine future engine health monitoring.

Start date: 1/10/13 | **End Date:** 30/6/17

Attributes: Cost, Operational Needs & Flexibility

Grant: £6.15m | **Total Cost:** £12.31m

Topic: Advanced Core

113019 – LAMPS

Project Title: Lightweight, Affordable Motors & Power-electronics Systems

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 3

Lead Partner: Goodrich Control Systems

All Partners: Goodrich Control Systems, Aero Stanrew, Raytheon Systems

Description: LAMPS addresses a critical part of the move to More-Electric Aircraft, creating a new generation of power electronics and motors. It has delivered concepts that will lead to substantial reductions in size, weight and cost. Achieving these reductions is vital due to the increasing numbers of motors and drives required on a future aircraft.

Start date: 1/6/14 | **End Date:** 31/8/16

Attributes: Fuel Efficiency, Passenger Experience

Grant: £1.33m | **Total Cost:** £2.41m

Topic: More Electric Aircraft

113021 – MAXIMAL

Project Title: MAnufacturing eXcellence in Metals for Aircraft Landing gear

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Secure | **No. of Partners:** 3

Lead Partner: Safran Landing Systems

All Partners: Safran Landing Systems, Advanced Manufacturing Research Centre, Manufacturing Technology Centre

Description: Safran Landing Systems through this project develops key manufacturing technologies to become a worldwide centre of excellence for titanium machining. Some of the areas developed in this project are: machining operations on titanium parts, automated inspection of main landing gear, exploration of additive manufacturing components.

Start date: 1/7/14 | **End Date:** 30/9/16

Attributes: Fuel Efficiency, Environment, Cost

Grant: £1.35m | **Total Cost:** £2.06m

Topic: Advanced Landing Gear Systems

113042 – FLG

Project Title: Future Landing Gear

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 8

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Advanced Manufacturing Research Centre, L.B. Foster Technologies, Meggitt Aerospace, National Composites Centre, Safran Landing Systems, Warwick Manufacturing Group, Zodiac Interconnect

Description: This project matures key technologies that reduce costs to the operator; save fuel; improve ground operations; simplify manufacturing and simplify maintenance. The project focuses on Electric Taxiing, load/torque sensing technologies, new composite components, ground control algorithms, robust sensing technologies and new landing gear materials.

Start date: 1/4/14 | **End Date:** 31/3/17

Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £7.16m | **Total Cost:** £14.02m

Topic: Advanced Landing Gear Systems

113043 – FSIR

Project Title: Fuel & Systems Integrated Research

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Secure | **No. of Partners:** 7

Lead Partner: Airbus Operations

All Partners: Airbus Operations, Airbus Group, Aston University, Eaton Aerospace, Shell Research, Ultra Electronics Holdings, University of Manchester

Description: The project focusses on the development of the next generation of fuel systems and enabling technologies and capabilities. These new technologies can supply current and future Airbus aircraft with the means to improve product competitiveness, reduce costs to operators and reduce emissions in-line with key industry targets.

Start date: 1/4/14 | **End Date:** 30/9/17

Attributes: Safety, Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £3.13m | **Total Cost:** £6.32m

Topic: Through-life

113077 – Platform 1

Project Title: Large Landing Gear of the Future

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Secure | **No. of Partners:** 8

Lead Partner: Safran Landing Systems

All Partners: Safran Landing Systems, Advanced Manufacturing Research Centre, Composite Metal Technology, Cranfield University, Dunlop Aircraft Tyres, National Composites Centre, Trelleborg, University of Cambridge

Description: The Large Landing Gear of the Future project will develop, mature and demonstrate technologies that improve the efficiency of aircraft landing gears in their design, manufacture, operation and cost of ownership. The project will use technology demonstrators representative of an operational landing gear to validate the project outcomes.

Start date: 1/7/16 | **End Date:** 31/3/21

Attributes: Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £12.41m | **Total Cost:** £24.84m

Topic: Advanced Landing Gear Systems

113080 – SAVANA

Project Title: Satcom and VHF Architectures for Nextgen Avionics

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 1

Lead Partner: Thales

All Partners: Thales

Description: The SAVANA programme develops the hardware/software and technologies required to develop the basis of the next generation Satellite Communications product within Thales UK using software defined radio technology for the next generation of civil aircraft. The technology will form the Core Building Blocks for the Future Generation of Integrated Modular Communications products.

Start date: 1/4/16 | **End Date:** 31/3/20

Attributes: Safety, Passenger Experience

Grant: £9.95m | **Total Cost:** £19.93m

Topic: Smart Systems

113090 – MEGCAP

Project Title: More Electric Generation & Controls for Aircraft Power

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 6

Lead Partner: Safran Electrical & Power

All Partners: Safran Electrical & Power, 3D Systems Europe, 3T RPD, MEP, Midland Tool & Design, Barden Corporation

Description: MEGCAP will re-invent the thermal management of the interior of aircraft starter-generator electrical machines. Project outputs will be equipment and products with higher efficiency, lower self-heating – leading to cooler and smaller equipment. The project will also advance the control electronics.

Start date: 1/6/17 | **End Date:** 28/2/21

Attributes: Fuel Efficiency, Passenger Experience

Grant: £4.16m | **Total Cost:** £8.31m

Topic: More Electric Aircraft

113095 – E2EEHM

Project Title: End-to-End Equipment Health Management

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Secure | **No. of Partners:** 5

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Advanced Manufacturing Research Centre, Artesis, Cranfield University, Oxsensis

Description: E2EEHM develops and links together future equipment health management technologies to create future value for products and services. Capability will be created in the areas of advanced sensing, communications, data mining and analytics. These technologies will be demonstrated to illustrate their potential to reduce operational disruption, maintenance cost and design conservatism.

Start date: 1/11/16 | **End Date:** 31/7/20

Attributes: Cost, Operational Needs & Flexibility

Grant: £4.49m | **Total Cost:** £8.97m

Topic: Through-life

113099 – SECT-AIR

Project Title: Software Engineering Cost and Timescales – Aerospace Initiative for Reduction

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 12

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Altran, BAE Systems, Cobham, D-Risq, GE Aviation Systems, Leonardo Helicopters, MBDA, Rapita Systems, University Of Oxford, University of Southampton, University of York

Description: SECT-AIR's aims are to develop strategies for the UK high integrity software industry to lower development costs and to scope a UK aerospace software centre-of-excellence to maintain these strategies in the future. SECT-AIR plans to define processes and technologies that will make a step change reduction to software development costs.

Start date: 1/7/16 | **End Date:** 30/6/19

Attributes: Cost

Grant: £4.96m | **Total Cost:** £10.16m

Topic: Smart Systems

113103 – SMPP

Project Title: Scaleable Multi-Platorm Power Systems

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: Safran Electrical & Power

All Partners: Safran Electrical & Power, GE Aviation Systems, Raytheon Systems, Rolls-Royce, Goodrich Control Systems

Description: SMPP will establish More-Electric Aircraft electrical systems requirements for a range of aircraft types and will develop systems and sub-systems that will work well together to address power generation, power distribution/conversion and flight critical power consumption. Airframers will be encouraged to contribute to and to evaluate the work performed.

Start date: 1/7/17 | **End Date:** 30/6/21

Attributes: Fuel Efficiency, Cost

Grant: £13.04m | **Total Cost:** £26.08m

Topic: More Electric Aircraft

113108 – OFD

Project Title: Open Flight Deck

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 5

Lead Partner: GE Aviation Systems

All Partners: GE Aviation Systems, BAE Systems, Coventry University, Rolls-Royce, University of Southampton

Description: Open Flight Deck (OFD) develops an open, accessible and standardised avionic platform for the flight deck which supports the introduction of new technologies, software applications and peripheral devices. The project also develops new crew aids to both optimise flight crew workload and improve situational awareness to extend safe aircraft operations.

Start date: 1/3/17 | **End Date:** 29/2/20

Attributes: Safety, Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £13.11m | **Total Cost:** £26.47m

Topic: Smart Systems

113109 – U-CAIR

Project Title: UK Cabin Air

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Secure | **No. of Partners:** 4

Lead Partner: Honeywell Aerospace

All Partners: Honeywell Aerospace, Gas Sensing Solutions, National Physical Laboratory, SST Sensing

Description: This project seeks to provide improved passenger experience and reducing airline operating costs. It is developing air quality sensors and cabin air management technology aimed at improving cabin air quality and increasing fuel efficiency. This project will enable the UK to lead the market in the definition of aircraft cabin air quality standards.

Start date: 1/4/17 | **End Date:** 30/6/20

Attributes: Safety, Fuel Efficiency, Cost, Passenger Experience

Grant: £2.20m | **Total Cost:** £4.39m

Topic: Through-life

113143 – FLG2

Project Title: Future Landing Gear 2

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 10

Lead Partner: Airbus Operations

All Partners: Airbus Operations, L.B. Foster Technologies, Meggitt Aerospace, National Composites Centre, Safran Landing Systems, Sigmatex, Smart Fibres, University of Southampton, Warwick Manufacturing Group, Zodiac Interconnect

Description: This project focuses on key areas of landing gear development: load/torque sensing technologies, new composite components, ground control algorithms, robust sensing technologies, wheel modifications and the use of new Landing Gear materials. The project enables the deployment on to existing aircraft as well as looking at an integrated solution on future aircraft.

Start date: 1/4/17 | **End Date:** 31/3/20

Attributes: Fuel Efficiency, Environment, Cost, Operational Needs & Flexibility

Grant: £8.04m | **Total Cost:** £16.08m

Topic: Advanced Landing Gear Systems

113145 – ENCASE

Project Title: Enabling Novel Controls & Advanced Software for Engines

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 8

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, Active Sensors, Aero Stanrew, Ionix Advanced Technologies, Newcastle University, Penny & Giles Controls, Porvair Filtration Group, University of York

Description: ENCASE develops key enabling technologies for the control system in the UltraFan™ engine demonstrator. These include electronic core concentrator control systems architecture, sealing & sensor technology, a "super" permanent magnet alternator and architectural safety critical software. A key benefit of ENCASE is delivering scalable solutions for both business jet and civil engines.

Start date: 1/9/17 | **End Date:** 31/8/21

Attributes: Safety, Fuel Efficiency, Cost

Grant: £9.24m | **Total Cost:** £18.50m

Topic: Ultra-high Bypass Ratio Engines

113155 – DE-ICER

Project Title: Delivering Excellence – Ice Crystal Engine Research

Value Stream: Smart, Connected and More Electric Aircraft

Time Horizon: Exploit | **No. of Partners:** 4

Lead Partner: Rolls-Royce

All Partners: Rolls-Royce, University Of Oxford, GKN Aerospace, Satavia

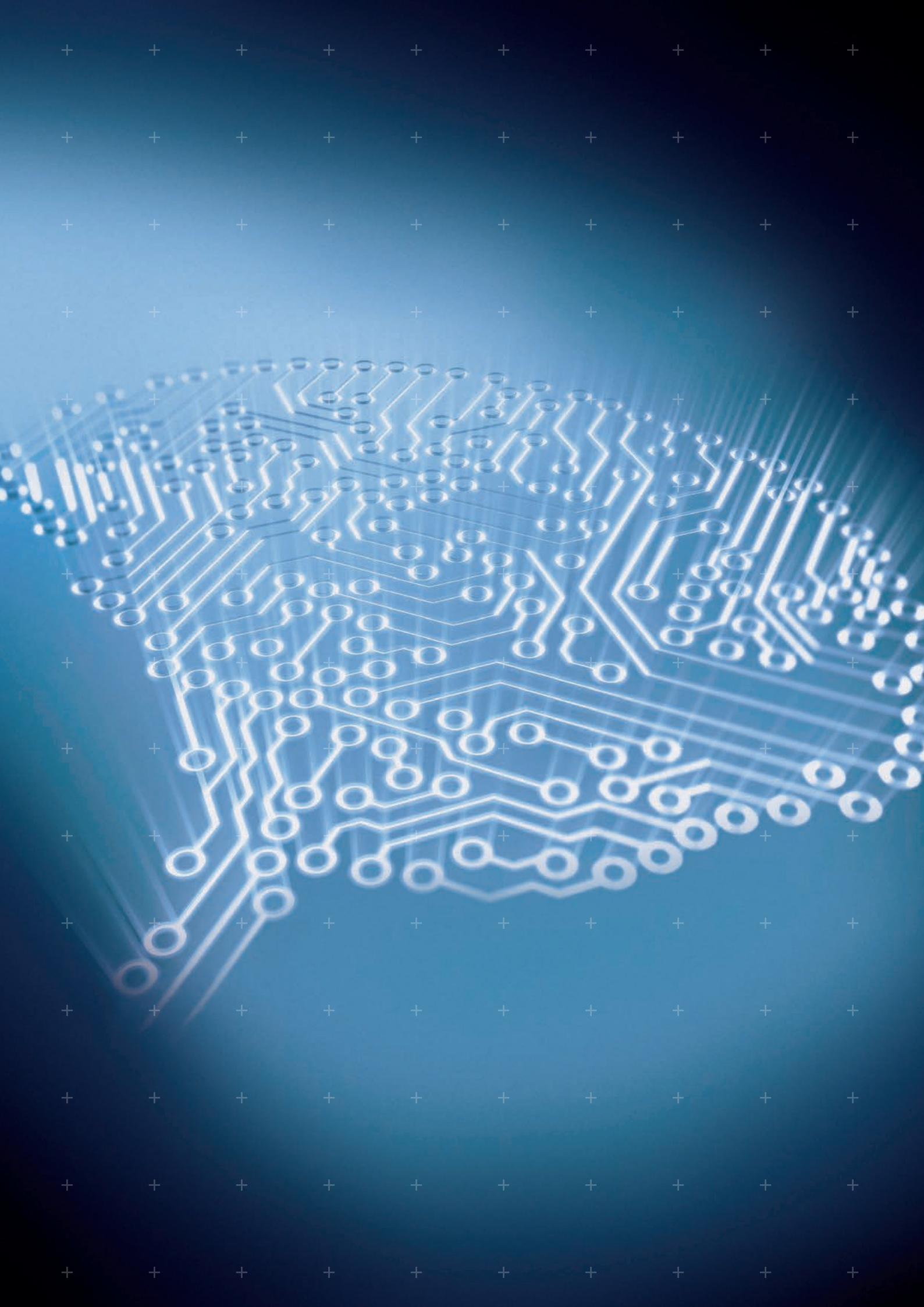
Description: This project develops design capability for ice crystal icing, in new engine architectures, as well as improved ice detection and anti-ice systems. The improved understanding of icing mechanics in combination, with an integrated icing protection system and better characterisation of the icing, ensures the UK remains competitive on future engine architectures such as UltraFan™.

Start date: 1/2/18 | **End Date:** 31/1/22

Attributes: Safety, Fuel Efficiency, Cost, Operational Needs & Flexibility

Grant: £7.05m | **Total Cost:** £13.79m

Topic: Ultra-high Bypass Ratio Engines



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