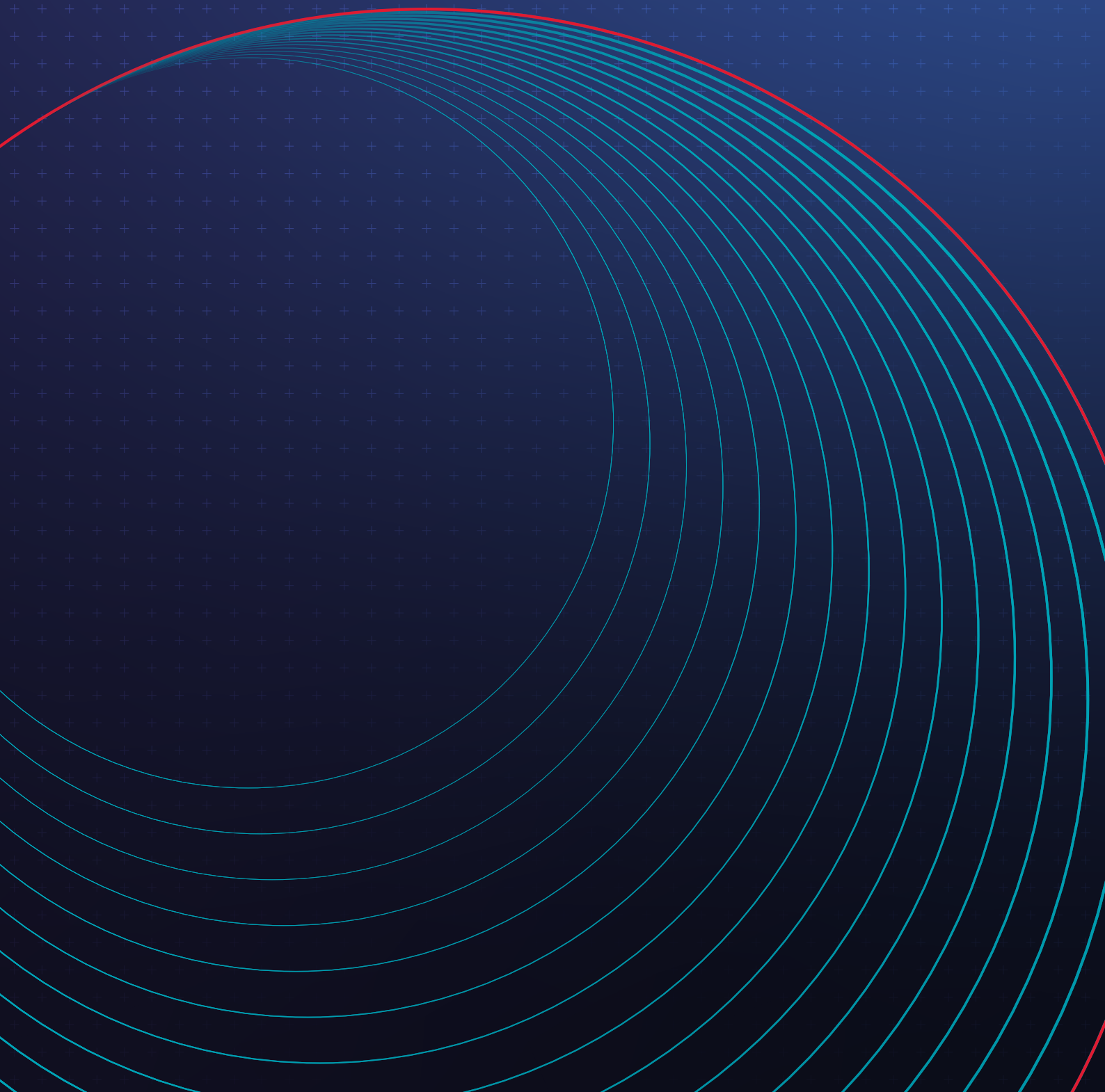
AEROSPACE TECHNOLOGY INSTITUTE

Annual Review

2019/20



CONTENTS

Note:

The Aerospace Technology Institute (ATI) believes the content of this report to be correct as at the date of writing. The opinions contained in this report, except where specifically attributed, are those of ATI, based upon the information that was available to us at the time of writing. We are always pleased to receive updated information and opposing opinions about any of the content. The content reflects the status of ATI-supported projects, the R&D landscape and economy during the ATI's 2019-20 financial year. At date of publication, the full impact of the Covid-19 pandemic on the aerospace sector was yet to be quantified. All images are reproduced with kind permission of the copyright holders.

INTRODUCTION

The Aerospace Technology Institute was created in 2013 and began operations in 2014. The ATI's role as a neutral presence between government and industry is to establish a challenging technology strategy for the sector, and to develop a portfolio of research and development (R&D) activity to realise the strategy, exploiting the sector's strengths to the full and creating new capabilities for the markets of the future.

These activities are carried out in industry, academia, and other research establishments. ATI projects are chosen and overseen through close collaboration with Innovate UK and the Department for Business, Energy and Industrial Strategy (BEIS).

Government and industry have agreed jointly to commit up to £300m per year in technology out to 2026, creating a total potential investment of £3.9bn.

The Institute supports the Aerospace Growth Partnership - a joint government and industry forum created to bolster the UK civil aerospace industry and enable it to reach its full economic potential in the global market.

The ATI's technology strategy is set out in *Accelerating Ambition* and other publications including its growing series of INSIGHT papers which explore individual technologies in more depth see page 27 for a full list of these. The ATI also publishes INSIGHT papers on the economics of aerospace technology. The portfolio of R&D activities is summarised in a project directory. All these resources are available on the website at www.ati.org.uk.

The ATI is a non-public body funded equally by BEIS and by industrial recipients of project grants who pay a small levy. Its running costs total around £5m per year. It operates in a complex environment with many partners and stakeholders in industry, academia, and government, based in the UK and overseas. The ATI board reflects this, drawing on the private and public sectors, and led by an independent non-executive chair.

Project ACCEL

HIGHLIGHTS OF THE YEAR

Launch of the MTC's AM innovation hub
Dr Simon Weeks, the ATI's CTO, cut the ribbon at the opening ceremony for the new hub for additive manufacturing.

Airspace 2050
Three potential future scenarios challenged assumptions in the ATI's thought-provoking publication.

FIA Connect
ATI colleagues presented and joined panels at Farnborough International Airshow's virtual event.

HRH Prince Charles visits the Whittle Lab
HRH Prince Charles unveiled a plaque to launch the ATI-supported National Centre for Propulsion and Power, before joining ATI's Chief Executive and CTO to discuss decarbonisation strategies.

ATI Conference
Over 350 delegates from more than 130 organisations attended the second ATI Conference to engage with over 50 keynote and breakout presentations.

Working Groups
The ATI's advisory groups were restructured to enable more targeted consultation with the aerospace sector.

UK Government R&D roadmap
The roadmap was welcomed by the ATI - net zero, Covid-19, and global competition will require the UK to be at the forefront of innovation.

UK-Sweden 2020
Seven projects were funded under the latest UK-Sweden joint R&D call.

Project ACCEL
Ground testing completed, preparing to break the world speed record.

Project HyFlyer in world first
ZeroAvia's HyFlyer project, funded through the ATI Programme, achieved the world's first hydrogen-electric passenger flight.

ATI Chair
The ATI welcomed Stephen Ball into the role of Chair.

FlyZero – launch, PD
The ATI launched its Government-funded zero carbon emission project.

Accelerating Ambition
We launched the updated UK aerospace technology strategy.

ATI Boeing Accelerator launch
The launch of the Accelerator was attended by Nadhim Zahawi MP.

Refreshed ATI website
The ATI website was given a refreshed look with updated content to better reflect the organisation and an interactive database of projects was created using SharpCloud.

Thought leadership
Three INSIGHT papers were published: The UK Cabin Opportunity, The Journey Towards Autonomy in Civil Aerospace, and The ATI Sustainability Framework.

Aero Guru
The ATI's Aero Guru events were held online, connecting start-ups with aerospace experts.

Hydrogen
The ATI submitted two cross-industry responses, to calls for evidence into technological innovations which could tackle climate change, led by the All Party Parliamentary Group on Hydrogen, and by the Environmental Audit Committee.

ATI joins Jet Zero Council
ATI's CEO joins other senior industry leaders to advise government on zero emission flight.

Sustainable Aviation's decarbonisation roadmap
The roadmap was launched by Grant Shapps MP, Secretary of State for Transport.

CHAIRMAN'S FOREWORD

I am delighted to present my first ATI annual report after taking up the position of chairman in January 2020. My thanks go to my predecessor Stephen Henwood who steered the ATI since its inception in 2014 and handed over an organisation in great form and on a healthy trajectory. This year saw a strong start as the Institute reaffirmed its role, launching a revised technology strategy and holding a very successful conference which I attended as chairman designate. Shortly afterwards, however, inevitably, the dominant issue became how to respond to the Covid-19 pandemic.

Covid has had a ruinous effect throughout the world. Its impact on aviation has been very stark, reducing the volume of flights to levels not seen since 1999, slowing aircraft production down significantly, and creating an unprecedented crisis in all parts of the industry. Many businesses have taken extensive measures in order to survive, bolstered by UK government support which has been swift and far-reaching.

"I congratulate the ATI team on responding flexibly and creatively to the new situation."

As the crisis has deepened, however, the focus on green growth has become sharper. Already a major theme in aviation before the pandemic struck, it now carries extra significance as a way out of the economic crisis and a route to recovery. The creation of the Jet Zero Council and the publication of the government's ten-point plan for a green industrial revolution indicate clearly the high priority the government attaches to this. The task for the ATI this year therefore has been how to work with an industry in crisis to raise its level of ambition and accelerate progress towards zero emission flight – helping both to combat climate change and underpin the government's move towards a green industrial revolution. I congratulate the ATI team on responding flexibly and creatively to the new situation.

Industry's commitment to research and development has remained high as the sustainability agenda has brought a fresh impetus. This demonstrates again the benefit and efficiency of the ATI's central role in convening the industry and setting the strategy. Launching the FlyZero initiative, described elsewhere in this report, has been a particular success.

Looking ahead, we are entering an exciting but critical period for the ATI. The technology challenges inherent in reaching a zero-emission future by 2050 call for intensified activity over the long term. It will be a major priority to put the necessary framework for this in place in order to secure the commitment of industry and government, and attract the world's leading companies and researchers to the UK.

In closing, I want to record my thanks to my fellow board members for welcoming me to the ATI and for the huge support they have given me in my first months. Their experience and expertise are a great asset to the organisation. This year we were pleased to welcome Susan Schofield from GKN Aerospace, who replaced Chris Gear.

Stephen Ball
Chairman, ATI

CHIEF EXECUTIVE'S FOREWORD

2020 will be remembered as the most challenging year ever for aerospace. Covid-19 has ravaged the sector and will continue to do so for some time. Nevertheless, the first half of our 2019/20 year preceded Covid and brought some major successes for the Institute.

In November 2019 we held a successful conference and launched a revised technology strategy focusing on sustainability, mobility, and competitiveness; the ATI Boeing Accelerator completed its first phase, demonstrating the potential of the concept; and a number of important projects were launched.

Covid's impact upon aviation and aerospace soon became clear. Additionally, Covid has coincided with a renewed push towards environmental sustainability. These various pressures clearly required a response and the Institute shifted quickly to meeting them as constructively as possible. Inevitably, the pandemic has brought unwelcome developments, including the discontinuation of the E-Fan X project, and delays to other projects. However, the response to our R&D calls has continued to be very enthusiastic, and attendance at virtual events has been high.

In conjunction with our partners at the Department for Business, Energy and Industrial Strategy (BEIS) and Innovate UK, we were able to enhance our support levels, to front-end our support to some projects, and most significantly, to launch a new programme called FlyZero. This was announced at Farnborough Connect in July 2020 and became a major focus for the Institute in the final months of 2019/20. We were delighted to welcome Chris Gear, former ATI board member and chief technology officer of GKN, as project director; and we are now supporting Chris in engaging a team of secondees from all around the industry to explore the prospects for a zero emission aircraft to be in service by 2030. The launch of FlyZero coincided with the government's launch of a senior council entitled Jet Zero. Chaired by the secretaries of state from BEIS and Department for Transport, this provides a platform to promote zero emissions flight in the UK, including the development of aircraft. I represent the ATI on this council.

The Institute continued to produce analysis on key topics, including INSIGHT papers on cabin interiors and autonomy, and a paper entitled "Three Futures" setting out potential scenarios for civil aerospace in the run up to 2050. We continued to support disruptive innovation through our Aero Guru sessions, helping fledgling businesses to access expert advice.

Internationally, the future relationship with the EU was an important topic, and we joined with the AGP, ADS and the UK Aerospace Research Consortium (UK ARC) to support continued access for UK organisations to EU R&D initiatives. We launched a second bilateral R&D call with Sweden, and maintained input into the Advisory Council for Aeronautics Research in Europe (ACARE), the Group for Aeronautical Research and Technology in Europe (GARTEUR), and the International Forum for Aviation Research (IFAR).

The Institute was active in providing advice and participating in discussions with government, including sitting on DfT's research and innovation board (TRIB). The Institute also contributed to consultations on decarbonisation, the R&D roadmap, and plans for an advanced research projects agency (ARPA).

Working with others remained a key objective. As well as collaboration with our partners at BEIS, Innovate UK and the Aerospace Growth Partnership (AGP), we contributed to the Future Flight, Driving the Electric Revolution, and Faraday challenges. We connected with airlines, airspace and airports, and across sectors including automotive and defence.

In closing, I want to thank and congratulate all the staff at ATI who have adapted so well to new working arrangements. Working from home for so long has not been easy, but the quality and quantity of output has remained very high. My colleagues have maintained great communications amongst themselves and launched many laudable initiatives to promote wellbeing, knowledge sharing and general bonding.

Gary Elliott
Chief Executive, ATI

Launched in July 2020, FlyZero is a unique research project aiming to realise the world's first zero carbon emission commercial flight by the end of the decade.

To remain sustainable and meet the government's target of net zero carbon emissions by 2050, aviation must transform itself radically, embracing a step change in the design, development, manufacture and operation of commercial aircraft. Backed by a £15m grant from BEIS, FlyZero will shape the next generation of global aviation and position the UK to stand at the forefront of sustainable flight in design, manufacturing, and skills. FlyZero will bring together 100 experts for an intensive 12-month collaborative programme to deliver a holistic and detailed study from propulsion to policy, systems to supply chain, and economics to environmental impact.

"Meeting the ambition of FlyZero and hitting the net zero target will require a long-term, collaborative approach across the whole of the UK aerospace industry. FlyZero kickstarts this process and will lay the ground for future innovation, investment and job creation."

Gary Elliott,
Chief Executive, ATI

This is a defining moment, akin to the advent of the jet age, and an opportunity for the UK aerospace industry to establish itself as a leader in sustainable aviation, building on decades of expertise in conventional aircraft. A new breed of aircraft will call for entirely new industrial capabilities which will lay the foundations for the future of the industry and its supply chain, just as investments made 40-50 years ago set up the aerospace industry we know today. Being at the leading edge of these new technologies is therefore vital to the UK's future competitiveness in the entire civil aerospace market as international competition in this arena intensifies.

"Moving to net zero emissions is imperative for global aviation and it is important to make rapid progress as the sector recovers from the Covid pandemic. I welcome FlyZero as an ambitious initiative to bring many talents together, drive up the pace of change, and make a challenge for UK leadership in net zero flight."

Prof. Iain Gray,
Director of Aerospace, Cranfield University

Since launch, the ATI has established the core functions of the FlyZero project including IT, finance and governance putting in place the necessary organisational and legal requirements to support the secondment of individuals into the team. The FlyZero team has grown rapidly in the first part of 2020/21 welcoming a diverse range of experts from across industry and beyond who have commenced the project research phase essential to the development of zero carbon emission aircraft concepts and associated economic, industrial and sustainability assessments.

FLYZERO WILL DELIVER

An assessment of the potential market
economic benefit, and environmental impact for a zero carbon emission commercial aircraft by 2030

A preliminary design for a zero-carbon emission commercial aircraft
to maximise environmental impact and drive deeper understanding of the economic, technical, and industrial challenges

Technology roadmaps
identifying key development issues

A requirement specification
as basis for future industrialisation and an accompanying roadmap

A baseline assessment
of the UK's current industrial footprint and capability

A sustainability assessment

"The team of experts we have established reflects the world-class and diverse knowledge and capability we have across the UK in aerospace, technology and beyond. Now, the pressure is on to revolutionise the future of air travel."

Chris Gear
Project Director, FlyZero

TECHNOLOGY STRATEGY

The updated UK aerospace technology strategy, *Accelerating Ambition*, was launched at the ATI Conference in November 2019, focused on sustainability, mobility, and competitiveness. The strategy prioritises the technology areas of power and propulsion, aerostructures, systems, and vehicles, as well as cross-cutting challenges such as high-value design.

The ATI offers prospective applicants four funding streams – the strategic programme, R&D for Smaller Business, the National Aerospace Technology Exploitation Programme (NATEP), and international funding calls. The ATI also engages with start-ups through the ATI Boeing Accelerator and its Aero Guru engagement programme.

ATI Programme funding streams

Aerospace Technology Institute (ATI) programme
£3.9 billion to 2026

ATI strategic programme	R&D funding for Smaller Business (ex. CR&D)	NATEP	International bilateral funding calls	ATI Boeing Accelerator
Key facts Total grant funding: £1.9bn Annual budget: £150m Project grant (avg.) £5.1m Project duration (avg.): 3 yrs **TRL 3 - 6**	**Key facts** Total grant funding: up to £20m 2019 call grant: £8m Project grant: £250k to £750k Project duration: 1-3 yrs **TRL 2 - 6**	**Key facts** Total grant funding: £13.7m 2019 call grant: £8m Project grant: up to £150k Project duration: up to 18 months **TRL 4 - 6**	**Key facts** Total grant funding: up to £2.25m UK-Sweden bilateral funding call launched in April 2020 **TRL 4 - 6**	**Key facts** £100k equity investment for start-ups - 3 month programme to support innovation in technologies for industry 4.0 for the UK's aerospace ecosystem

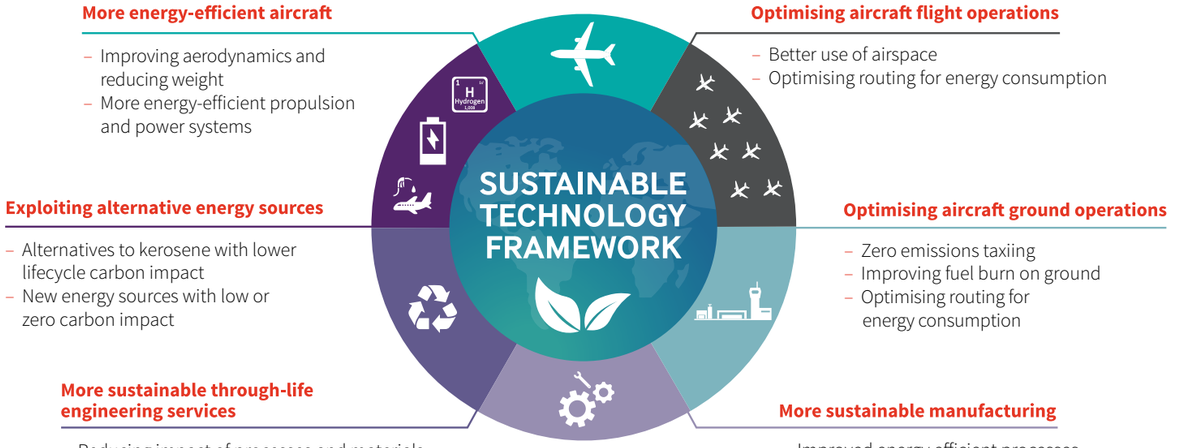
Sustainability

Sustainability is a key theme of Accelerating Ambition. This year many organisations in the industry have made bold commitments to decarbonise. The ATI has collaborated with the Department for Transport, the Sustainable Aviation coalition, and many other UK and EU-based committees to provide advice on technology to help the sector to decarbonise. To succeed, however, the sector requires targeted investment in sustainability improvements. This is set out in a new framework in the ATI's INSIGHT paper on sustainable aviation.

Sustainability covers the whole aircraft lifecycle. Work is underway through the ATI's industrial and research partners to develop modelling, frameworks, and processes to address wider sustainability aims such as materials usage, waste, and recyclability. Data will be provided by demonstrator projects that will feed into future aircraft programmes.

This will all be delivered with the aim of incentivising a broader portfolio of projects. The ATI will:

- Accelerate technologies with the most potential
- Support technology in areas where the current portfolio is thin, for example engaging with non-aircraft manufacturers in the wider air transport arena, where solutions for flight and ground operations are being developed
- Work with government and others to fast-track ways to exploit alternative energy sources such as bio and fully synthetic fuels, and hydrogen
- Deliver larger-scale, more ambitious, UK-based, low or zero carbon demonstrators.



ATI PROGRAMME

During 2019/20 the programme portfolio grew to a total investment of £2.8bn, and at year end there were 172 live projects.

The unique partners in the programme now surpass 340, including the addition of 62 SMEs over the past year, supported by additional grant funding of £24m. The ATI is particularly pleased that SMEs now make up close to two-thirds of all project partners, which demonstrates their commitment to innovation and the ATI's continued efforts to engage small businesses through R&D for Smaller Business, NATEP, the ATI Boeing Accelerator and Aero Guru events.

The portfolio continued to deliver new projects across all four priority technology areas with R&D being undertaken in all regions of the UK.

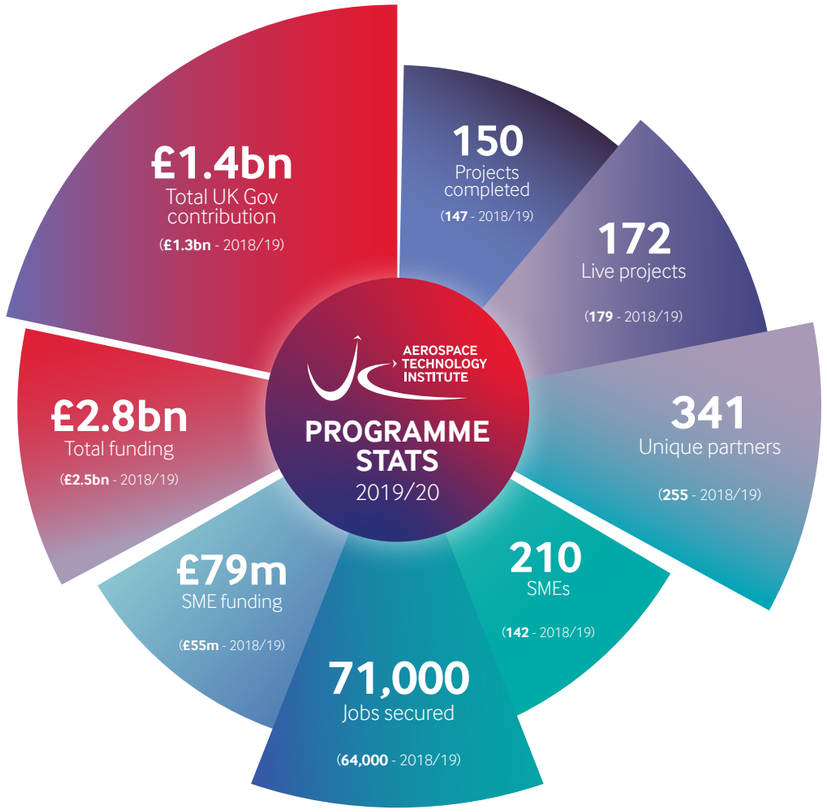
Academia

Academia is vital to the ATI. Academic experts provide input into the technology strategy, participate in the Institute's advisory groups, and often play a key role in ATI projects. UK universities offer unrivalled expertise in a broad range of disciplines, they are home to essential and sophisticated research infrastructure, and their involvement in the catapult network further underlines their role. Around 40 universities are engaged in ATI projects from the north of Scotland to Southampton. The ATI has invested in many leading facilities such as the Whittle Laboratories in Cambridge, the Osney Thermo-Fluids Laboratory in Oxford, the largest European titanium casting facility in Sheffield, and the National Centre for Combustion and Aerothermal Technology (NCCAT) in Loughborough. The UK Aerospace Research Consortium (UK ARC) has been created to coordinate the aerospace capabilities of currently eleven universities, exploiting the benefits of collaboration and creating a unified offer to industry.

"UK universities are a huge asset for aerospace, and we are determined to remain at the forefront of innovation as the zero emission era dawns, working with industry primes and start-ups alike. Building on acknowledged research excellence in aerospace, exciting new facilities and capabilities are coming on stream up and down the country to keep the UK ahead in sustainability, new forms of mobility, and high-value manufacturing."

Prof. Iain Gray,
Director of Aerospace, Cranfield University, and President, UK ARC

Year on year



Strategic programme

The strategic programme is made up of four priority technology areas. These are: Propulsion and power, Aerostructures, Systems, and Vehicles.

Propulsion & power

Work on the Rolls-Royce UltraFan® demonstrator continued, with projects focused on areas such as lightweight composite fans, external sub-systems, power and transmissions, engine performance analysis and demonstration.

A key national infrastructure facility known as Testbed 80 is nearing completion in Derby. It is the largest of its kind in the world and will have the capability to test hybrid, all-electric and gas turbine engines. In Loughborough, the National Centre for Combustion and Aerothermal Technology (NCCAT) was formally opened. In addition, construction at Oxford Osney continues, supporting the Osney Thermofluids lab as a global centre of excellence in turbomachinery and thermal management.

In other areas of propulsion and power, projects have focused on future product capability, and advanced disruptive tools and methods. One example of this is the COLIBRI (Collaboration Across Business Boundaries) project which was launched as a result of the ATI's engagement with stakeholders in our advisory network to develop an open collaborative project. COLIBRI will explore and develop new tools that exploit advances in artificial intelligence and machine learning to improve and speed up the collaborative design environment for the UK's aerospace design community.

SUSTAINABILITY CASE STUDY

NCCAT (National Centre for Combustion and Aerothermal Technology)

Partners: Loughborough University, Rolls-Royce

NCCAT will act as the UK's primary R&D hub for low emission aero gas turbine combustion technologies, which utilise either conventional or alternative sources of energy. The facilities enable low emission combustion technology to be designed, modelled, and simulated with unprecedented agility. Primarily focused on aerospace, NCCAT's capabilities will also support other UK sectors such as distributed power generation, and the development of measurement technology for harsh environments. NCCAT's state-of-the-art facilities will significantly accelerate the pace at which new technologies can be proven and adopted to achieve a greener and sustainable future for the UK aerospace industry.

"The University is delighted to be developing this pioneering National Centre of Excellence. Loughborough has a long tradition of working closely with industry, aligning its research activities with the requirements of companies and organisations. The boundaries between research, design, development and manufacture are becoming increasingly blurred, and so it makes absolute sense to bring the researchers and engineers together to ensure the fast pull through of technology to industry."

Professor Robert Allison,
Vice Chancellor and President of Loughborough University.

Aerostructures

Aerostructures play a vital role in realising more efficient aircraft, through lightweighting and more aerodynamic, multifunctional structures. Digitalisation is playing a larger role, from design optimisation to manufacturing data linked with the supply chain.

These improvements are enabled by technologies which manufacture components and complete assembly at higher rates. Advanced, adaptable automation performs to the highest quality and safety standards and is competitively priced. Significant progress has been made in high-value design, with much of the cost and performance determined up front. Virtual testing has accelerated the optimisation of complex and multi-material structures.

The Wing of Tomorrow programme led by Airbus has progressed to the manufacture of full-scale composite wing components, developed on new equipment demonstrating unique and world-leading capability. These have been produced in open access research facilities across the UK, notably GKN's Global Technology Centre (GTC) and Spirit Aerosystems' Aerospace Innovation Centre (AIC). AMRC Cymru transitioned temporarily to a ventilator assembly line in response to the Covid pandemic, and has since been reconfigured for the Wing of Tomorrow 17m full wing demonstrator assembly line.

The ATI developed a casting technology roadmap, through engagement with our stakeholders from across industry and the supply chain, as part of the drive to improve sustainable manufacturing and competitiveness in metallic technologies. A series of webinars discussed the opportunities, the sector's requirements, developments in academia, and areas of common interest with the automotive sector. This has led to a number of collaborative projects being developed and submitted for the ATI programme.

The ATI's stakeholder working groups have also captured the key strategic needs for composite tooling and automated assembly manufacturing, defining direction for future investment.

COMPETITIVENESS CASE STUDY

iCAP (Innovation Capabilities)

Partner: The National Composites Centre (NCC)

In 2020 the NCC unveiled the latest phase of the most advanced composite manufacturing facility in the world. Part laboratory, part factory, it is the result of a £36.7m R&D programme to harness the power of new digital technologies.

In the UK alone, the value of composites is expected to reach c.£12.5bn by 2030. Aerospace is a significant driver of demand. For the past two years, a team of engineers, researchers, software architects, roboticists and textile experts have explored how digital technologies can make composites easier to design for, as well as quicker and cheaper to make. A key goal was to demonstrate that they could be a viable, mass-producible alternative to traditional metallic parts. The results of this research are 10 new machines which redefine the state-of-the-art for composite manufacturing.

"The investment in 10 new world-leading composites capabilities will enable us to develop the wings and engines for the aircraft of the future, work on technologies that will define the way we produce and store energy and transform the way we build infrastructure."

Richard Oldfield,
CEO, The National Composites Centre

Systems

There have been several significant projects launched over the past year, including:

- **AEPEC** (Aerospace Electric Propulsion Equipment, Controls & machines) a £21.5m project led by Safran which develops critical electrical machine capability and further develops the UK supply chain
- **IPCCA** (Integrated Power Conversion and Control Architecture) a £4.8m project led by Collins Aerospace with UK partners, developing a 50-60% weight saving in motor drive electronics
- **AISA** (Advanced Inlet Systems Architecture) a £3.9m project led by GKN with UK partners, developing advanced active inlet systems including ice protection
- **FQIS** (Fully Fibre Optic Fuel Quantity Indication System) a £4.8m project from Boeing which removes the need for electrical power in the fuel tank.

The ATI team have continued to develop the unique pre-conceptual systems modelling tool known as the Systems Virtual Validation Platform (SVVP), supported by AKKA and the University of Strathclyde to help validate some aspects. A specific use case was analysed in which a UK SME used SVVP to understand the benefits their technology could bring to the aerospace sector.

In response to the Covid pandemic and its impact on the aviation industry, the ATI has conducted a biosafe study to identify opportunities and risks to re-establishing the air transport industry.

In September, the ATI co-hosted an event with Warwick Manufacturing Group on the electrification supply chain, investigating opportunities in machines and drives, energy storage and systems integration. In October, the ATI ran a cabin interiors event which brought together over 200 stakeholders to build potential consortia in cabin systems technology.

Vehicles

The ATI's whole aircraft capability ensures that the UK remains able to understand which technologies to develop, how these may be integrated into a vehicle and what the benefits are at aircraft level. The full potential of new technologies will only be realised through early consideration of their impact at the aircraft level, and subsequent optimisation across systems and sub-systems.

The ATI has continued to build its whole aircraft modelling capability to include hybrid and all-electric designs, to assess the latest concepts and technologies being generated in the UK. As part of this strategic capability, the Single-Aisle Future Aircraft Model (SAFAM) has been created to assess evolutionary technology opportunities against global aviation sustainability targets.

The ATI also plans to develop a widebody model, with the intent to offer both for use by UK organisations.

There has been a significant increase in the number of disruptive aircraft concepts in the UK. The FlyZero project was launched by the ATI to take an objective look at the technology, commercial and sustainability factors in realising a step change in aviation emissions. This project will dovetail with the ATI's whole aircraft modelling capability to ensure the lessons learned from this project can be used for the benefit of the wider UK aerospace industry.

COMPETITIVENESS CASE STUDY

IVHM-EVOLVE – (Integrated Vehicle Health Management - Ecosystem of Intelligent Self-Organising Sensor Nodes for Helicopter Health Monitoring)

Partners: Helitune Limited (lead), XMOS Limited, Queen Mary University of London, University of Bristol

Commercially available health monitoring systems are often too heavy and large for small and medium sized helicopters. This project aimed to create a distributed network of intelligent sensors for helicopter health monitoring, significantly enhancing the system's effectiveness and reliability. This allows real-time reporting of health issues, enhanced decision-making, and timely maintenance actions.

A technology demonstrator of the sensor system and a graphical user interface have been developed. Further work in collaboration with an OEM is required to develop a prototype system that can be deployed in two different airframes in preparation for aircraft type certification. The consortium will investigate the future exploitation of its technology to other areas, including fixed-wing aircraft, UAVs, industrial power and renewables.

"The importance of being involved in these collaborative projects is crucial for smaller companies and offers the invaluable experience of working directly with the OEMs, who ultimately exploit the final commercial product. These programmes offer the security and opportunity for SME companies to plan 6-7 years in advance, whilst developing key relationships, to maximise our R&D output."

Peter Morrish,
Technology Manager, Helitune

COMPETITIVENESS CASE STUDY

EMPAS (Electric Motor-Powered Aero-engine Simulator)

Partners: QinetiQ, Boeing, Collins Aerospace, Ate AEROTECH, University of Surrey

EMPAS is a joint UK/US effort to demonstrate the validity of using electric motors to power the fan of engine simulators on wind tunnel models. EMPAS aimed to show that an electric motor would:

- **Greatly increase the ease of use**
- **Increase energy efficiency**
- **Leverage existing test facilities**
- **Allow for the more rapid development of use-specific engine simulators, eg. for novel propulsion concepts**

A prototype engine nacelle was designed for the QinetiQ 5m wind tunnel at Farnborough. A small electric motor was produced to develop a fan pressure ratio of 1.45 at 45,000rpm up to Mach 0.3. However, concerns for fan flutter reduced the final test speed to 42,000rpm.

The EMPAS unit was tested across its intended operating range, meeting the expected criteria. It ran at 42,000rpm faultlessly, absorbing 130kW and producing a fan pressure ratio of 1.4. The running time of the unit was over 30 hours, with an estimated power use efficiency of over 80%.

"With considerably improved energy efficiency and less infrastructure requirements, EMPAS units will make the use of engine simulators much easier, leading to greater utilisation and higher fidelity test simulations."

Malcolm Pembury,
5m Wind Tunnel Test Controller, Qinetiq

R&D for Smaller Business

This funding stream is aimed at smaller businesses and funds projects that will demonstrate forward-looking and disruptive solutions to UK civil aerospace challenges. Three calls took place between 2018 and 2020. The autumn 2019 call committed a total of £4.7m grant funding and yielded 11 projects involving 31 participants. It enabled three types of project to take place: fast start, standard collaborative research and development, and feasibility studies. Technologies represented in this call included advanced manufacturing, predictive analytics and materials management. A further call took place in autumn 2020, providing a further £2.3m in grant funding and generating an additional five projects with a total of 16 participants. Projects in this call were all of the standard collaborative research and development type. The ATI and its partners in BEIS and IUK will review the possibility of further calls being made under this initiative in future.

COMPETITIVENESS CASE STUDY

FES (Future Engineering Systems)

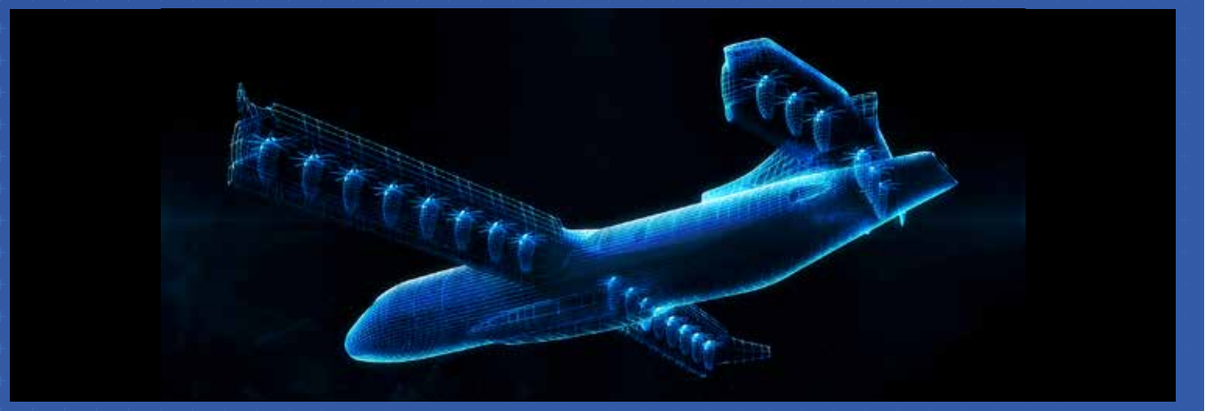
Partners: The Centre for Modelling & Simulation (CFMS), eQ-Technologic, Leeds University Socio-Technical Centre, Rolls-Royce, Sheffield University, Siemens, Sysemia

FES developed and demonstrated a prototype system integrating complex engineering data from various sources into the process lifecycle management (PLM) tool chain. PLM systems enable efficient, cost-effective management of the product lifecycle, but they struggle to process the high volumes and complex formatting of raw engineering data.

The project created demonstrators which highlight and validate the new product lifecycle approaches. The technology progressed from TRL 3 to TRL 5, and enabled performance improvements an order of magnitude faster, via a framework to automate integration of modelling systems. FES also developed intellectual property in increased speed computational fluid dynamics. The technology developed is applicable across multiple sectors, with direct benefit to those in aerospace, automotive, construction and energy production.

"This technically challenging research has delivered an integrating framework, which when simulation tools and data sources are incorporated, will enable a dramatic speed up in optimisation of aircraft propulsion systems."

Tony Phipps,
Chief of Future Methods, Rolls-Royce



National Aerospace Technology Exploitation Programme

NATEP targets companies inexperienced at R&D. It helps fund small projects and provides in-kind support to set up and run them. It also engages potential customers (or end users) interested in exploiting the resulting technology. Following two successful phases of NATEP, a third phase was launched in August 2019 with £10m public support through the ATI budget, aiming to create over 60 projects over four years. Forty-four projects have so far been funded in this phase. Following changes to the ATI's grant regime introduced in response to Covid, SMEs are now entitled to 70 per cent funding of projects with a value of up to £300k. Case studies and project videos are available on the newly refreshed NATEP website www.natep.org.uk. Many projects started late due to Covid, but demand is up for the programme, with further funding calls expected to be announced in 2021.

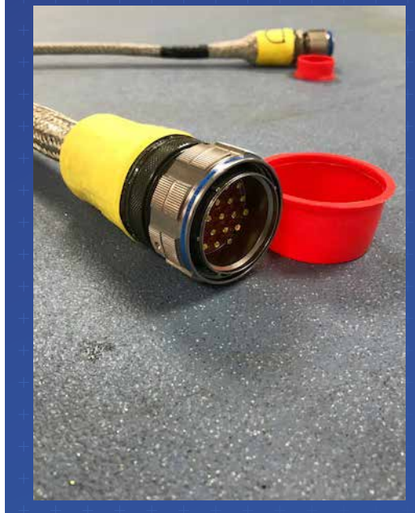
"Many SMEs cannot undertake R&D activities without additional funding, so we are very pleased to see continued commitment from the UK Government in supporting the aerospace supply chain in the UK. NATEP is now an established part of the ATI portfolio and a key route for directing R&D funding to smaller businesses. With the changes in funding weighting, we hope that many more SMEs will participate in future phases of the programme."

Harriet Wollerton,
Programme Director, NATEP

COMPETITIVENESS CASE STUDY

Fit and Forget Harness

Partners: SMI, Safran UK, Concept Cables



Reducing through-life costs can be a challenge in aerospace, as upgrading non-critical systems may not warrant the disruption. SMI, with its project partners, applied the design methodology it uses on submarines to aircraft landing gear. Commercial aircraft operators replace cabling systems and sensors when they fail, whilst in submarines they must last for the life of the boat. The project concentrated on two systems on the landing gear: a branch assembly, and a bogie beam harness with breakout positions. The partners developed a way of sealing the connectors, including the termination points, inside a robust linear low-density polyethylene (LLDPE) jacket and built samples for validation.

SMI is now in discussions with a helicopter manufacturer, with military aviation and unmanned aerial systems (UAS) as potential areas of interest. Spillover applications might also be found in subsea, tidal and wind farm renewable electricity generation.

"We wanted to show the OEM advancements and improvements on what they had. We could give them a more reliable system, more tolerant to the environment, requiring less maintenance. We can see lots of advantages in pursuing this technology onto an aircraft. We believe this innovation will benefit the industry."

Glen Richardson,
CTO, SMI

International

International collaboration is important in a global industry, particularly where, as in the UK, much of the industry is headquartered overseas. As well as its many connections with overseas companies, the ATI engages with various organisations to understand, influence, and facilitate UK participation in the international aerospace research agenda.

With the majority of international R&D collaboration in aerospace taking place under the European Union's framework programmes, the UK's relationship with the EU remained an important focus during the 2019-20 business year. The Institute worked with the AGP, ADS, the UK ARC and others to urge the government to ensure continued access for UK organisations to EU R&D initiatives such as Clean Sky, preferably through negotiating associate country status. Fortunately, this position was reached in the EU-UK Trade and Cooperation Agreement signed on 24 December 2020. The ATI also contributed to the development of future EU research and innovation initiatives, responding to the European Commission's consultation on the European Clean Aviation Partnership (the successor programme to Clean Sky). Contact and influence has been maintained with key international and European groups and committees, and the ATI continued to represent the interests of the UK aerospace sector on committees of the Advisory Committee on Aviation Research and Innovation in Europe (ACARE), the Research and Technology Commission led by the European trade association ASD, the Group for Aerospace Research and Technology in Europe (GARTEUR), and the International Forum for Aviation Research (IFAR).

Bilateral initiatives continued, with the second UK-Sweden joint call for aerospace projects concluding in September with seven successful projects. The high level of interest and number of applications demonstrated the interest of the sector in bilateral collaboration. Discussions for future bilaterals continued with colleagues in Canada and the Netherlands.

CASE STUDY

HEPBAS (High Energy Propulsion Battery System)

Partners: Electroflight, Heart Aerospace, Baines Simmons, RISE

The ATI and Innovair, the Swedish programme for aeronautics, together with delivery partners Innovate UK and Vinnova, launched a funding call for aerospace R&D projects in 2020.

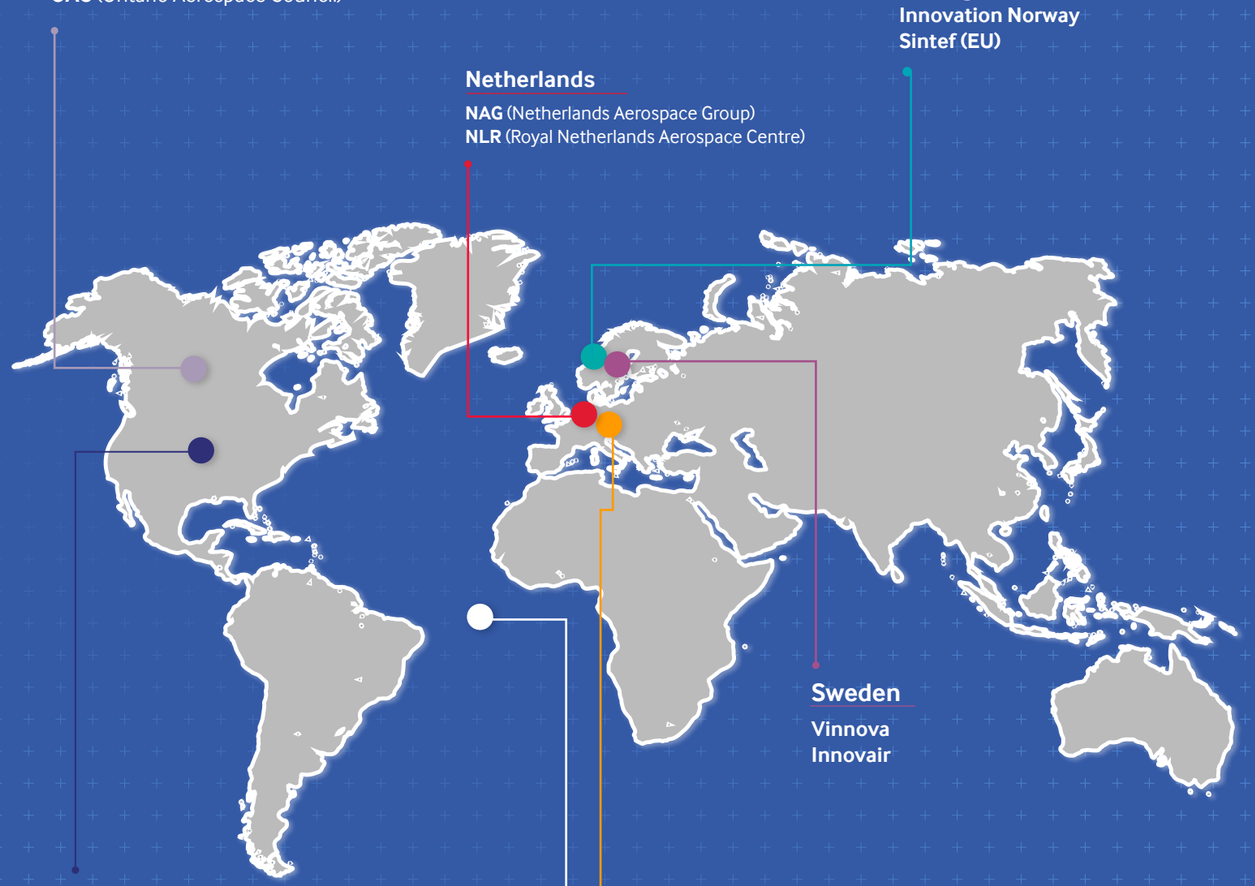
The call was designed to foster R&D projects between the UK and Sweden to advance both countries' pursuit of transformative technology in air transport and builds on the first UK-Sweden funding call launched in 2018.

HEPBAS is one of the successful projects which secured funding from the 2020 call, and will develop a battery system to power a new, all-electric regional airliner; the ES-19. The project will design, build and ground test an innovative prototype high energy battery pack, battery management system and onboard charger. The ES-19, which is under development by Heart Aerospace, will be capable of carrying 19 passengers with a range of 400km, powered by four electric engines which will be fed by the new battery system created by Electroflight.

"At first flight, this could well be the largest certifiable battery system in existence. Achieving this sort of breakthrough in electric aviation technology during such a disrupted and challenging year shows the incredible resilience and innovation in our industry. We are proud to be a part of this ground-breaking project and can assure everyone there is plenty more to come in the near future."

Douglas Campbell,
Technical Director, Electroflight

2019/20 international collaboration



ATI Boeing Accelerator

The ATI Boeing Accelerator supports innovative start-ups to break into the UK's aerospace ecosystem, bolstering growth and competitiveness.

The first three-month cycle was successfully completed in March 2020. Nine start-ups graduated from the programme, benefitting from first-hand access to strategists, technical experts and more from the ATI, Boeing, and the Accelerator's partner and corporate sponsor GKN Aerospace. Direct access was one of the most desirable aspects of the programme, and Cohort 2 will benefit from the additional expertise of Rolls-Royce, who joined as a programme partner in September.

"In what can sometimes be seen as a challenging industry to enter, the accelerator provides an excellent opportunity for mentoring, networking and investment; removing the barriers for disruptive companies to work in aerospace."

Gary Elliott,
Chief Executive, ATI

"We're thrilled to be involved in this program again and are excited to see how the accelerator builds on the companies' existing capabilities and their ability to impact aerospace with their innovation."

Brian Schettler,
Senior Managing Director, Boeing HorizonX Global Ventures

Cohort 1

- **268 applications**
- **9 start-ups**
- **£100k equity investment per start-up**
- **195 training hours**
- **>£6m additional funding secured**
- **30 jobs safeguarded**

Circulor · FILAMENT · intellegens · SEPTILLION PHYSICAL TO DIGITAL · AUTHENTISE · Perpetual Labs · gravity sketch · plyable · KRAKEN IM

CASE STUDY

Circulor

Among the inaugural programme successes are Circulor, a start-up that helps businesses demonstrate responsible sourcing through supply chain traceability, which raised £3.5m from Volvo Cars Tech Fund and Total Carbon Neutrality Ventures, among other investors.

CASE STUDY

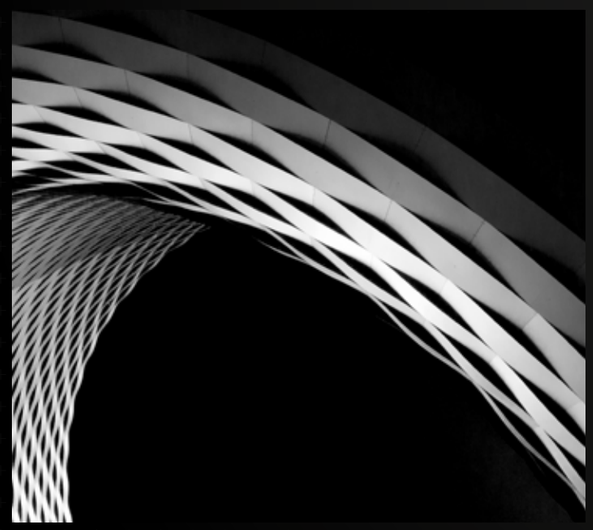
Filament

The company's AI-based software detects and repairs defects in aircraft parts. It won the Zamma Award at NTT Data Open Innovation Contest in Tokyo and was selected for Founders Factory. Filament also created a digital parts identifier which was used in the VentilatorChallengeUK programme.

CASE STUDY

Intellegens

This artificial intelligence (AI) company developed a unique deep-learning algorithm. They received Innovate UK funding to model Covid-19 data from around the world and improve the management of future outbreaks and other global pandemics. Intellegens are also leading a NATEP project.



Cohort 2, January 2021

The second cohort features ten sustainability-enabling start-ups that will benefit the UK aerospace industry across three key areas of focus: Industry 4.0, Lifecycle and Resilience, and Energy.

The start-ups will benefit from:

- £100,000 equity investment from Boeing HorizonX Global Ventures
- First-hand access to ATI, Boeing, GKN Aerospace and Rolls-Royce strategists and technical experts
- Mentoring from a global network of experienced entrepreneurs, mentors and investors
- Access and introductions to our network of angel investors, venture capital firms and the wider aerospace industry throughout the programme and during ecosystem events.

COMMUNICATIONS AND OPERATIONS

The ATI Conference in November 2019 drew a record number of delegates from over 130 organisations, featured 50 presentations, exhibitions, and pitches from SMEs. Two major pieces of work were launched - the updated UK aerospace technology strategy, *Accelerating Ambition*, and a refresh of the ATI website.

The Institute has adapted to the changing circumstances presented by the pandemic by maintaining a 'business as usual' approach as far as possible, by working from home and investing in the tools necessary to do so. One of the key priorities was to ensure the ATI programme remained open and accessible, and this approach is validated by record numbers of applications. The ATI-BEIS-Innovate UK Comms Group continued to meet on a monthly basis to ensure alignment and prepare project announcements, with increased ministerial engagement. The ATI continues to take an active role in the AGP Engagement Group, which brings together organisations from across the sector, in government and local administrations.

The cancellation of Farnborough International Airshow signalled an industry-wide move to digital and FIA Connect was created. The ATI presented four sessions: The UK Cabin Opportunity, Airspace 2050 (to coincide with the publication of Airspace 2050: Three Futures), and overviews of the ATI programme and the ATI Boeing accelerator.

As part of the ATI's remit to convene the sector, virtual events have created opportunities for engagement and improved accessibility. Webinars were held for the launch of the ATI's INSIGHT paper on autonomy, a joint event with Warwick Manufacturing Group on electrification, and another with the National Composites Centre on The Cabin Opportunity, which drew over 200 registrations to hear from 25 keynote speakers and panellists. Hosting events virtually has not only enabled more participants, but also more discussion, questions and interaction between professionals. Planning for the next ATI conference is underway.

OUR PEOPLE

New faces joined the Institute this year, bringing with them a diverse range of experience and opinion. The Institute launched a new development framework to support staff, and the internal 'Teaming Team' delivered cross-team collaborative sessions throughout the year, learning opportunities, and a session on mental health awareness whilst remote working. Recognising the importance of staff wellbeing while working from home, internal communication increased, including the frequency of internal newsletters and briefings delivered by the Executive Management Team.

This year, the Strategy team was joined by a student from the University of Bristol for a year in industry placement. Yasmin Zanker is a second-year student studying Mechanical Engineering.

"I have had the occasion to be involved in many different projects across the ATI. Working with the strategy team to develop an online interface for the market model, with the accelerator team to help select and support start-ups, with the technology team doing competitive and much more! This internship has widened my perspective on the aerospace industry, shown me how new technologies can be developed and how the whole industry is interlinked. This internship has been amazing, and one of the best parts is the opportunity to work on a variety of projects across the team: I am continually learning from everyone and developing my skills."

Yasmin Zanker

FINANCE

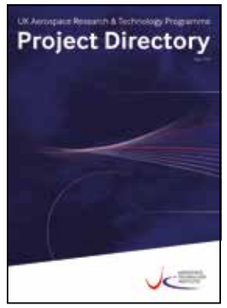
The ATI is a not-for-profit organisation, funded jointly by a government grant and industrial contributions. Total expenditure for the year was £6.3m, covering the costs associated with the ATI's specialist activities in R&D and stakeholder engagement, personnel and premises.

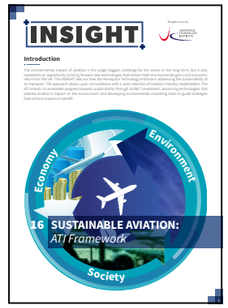
The total expenditure for 2019/20 represents a saving of nearly £630k from the annual budget, which continues to reflect the ATI's prudent approach to financial outlay and the organisation's response to the Covid pandemic to achieve maximum costs savings.

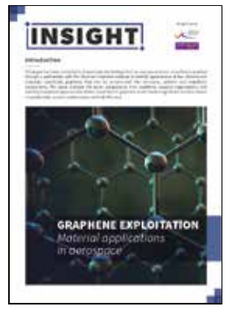
GLOSSARY

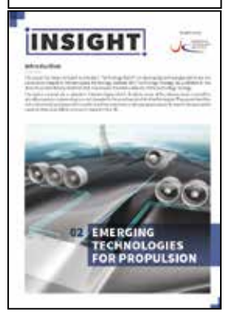
ACARE	**Advisory Council for Aviation Research and Innovation in Europe**
ADS	**Trade association for UK aerospace, defence, security and space**
AEPEC	**ATI-supported project: Aerospace Electric Propulsion Equipment, Controls & machines**
AGP	**Aerospace Growth Partnership**
AI	**Artificial intelligence**
AIC	**Aerospace Innovation Centre**
AISA	**ATI-supported project: Advanced Inlet Systems Architecture**
AMRC	**Advanced Manufacturing Research Centre**
ASD	**AeroSpace and Defence Industries Association of Europe**
BEIS	**Department for Business, Energy & Industrial Strategy**
CFD	**Computational fluid dynamics**
COLIBRI	**ATI-supported project: Collaboration Across Business Boundaries**
CRIAQ	**Consortium for Research and Innovation in Aerospace in Quebec**
DfT	**Department for Transport**
DIT	**Department for International Trade**
FES	**ATI-supported project: Future Engineering Systems**
FQIS	**ATI-supported project: Fully Fibre Optic Fuel Quantity Indication System**
GARTEUR	**Group for Aeronautical Research and Technology in Europe**
GTC	**Global Technology Centre**
HEPBAS	**ATI-supported project: High Energy Propulsion Battery System**
ICAO	**International Civil Aviation Organisation**
IFAR	**International Forum for Aviation Research**
IP	**Intellectual property**
IPCCA	**ATI-supported project: Integrated Power Conversion and Control Architecture**
IUK	**Innovate UK**
LLDPE	**Linear low-density polyethylene**
ML	**Machine learning**
NAG	**Netherlands Aerospace Group**
NASA	**National Aeronautics and Space Administration**
NCCAT	**ATI-supported project: National Centre for Combustion and Aerothermal Technology**
NLR	**Royal Netherlands Aerospace Centre**
NRC IRAP	**National Research Council of Canada, Industrial Research Assistance Program**
OAC	**Ontario Aerospace Council**
OEM	**Original equipment manufacturer**
PLM	**Process lifecycle management**
R&D	**Research and development**
R&T	**Research and technology**
SAFAM	**Single-aisle future aircraft model**
SIN	**Science and Innovation Network**
SME	**Small or medium-size enterprise**
SVVP	**Systems virtual validation platform**
UK-ARC	**UK Aerospace Research Consortium**

RESOURCES









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