

UK-Aerospace Research Consortium – expanding the value of UK academic research

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Abstract

The UK Aerospace Research Consortium (UK-ARC) is recent academic initiative that is channeling a broad range of research expertise to address aviation sector growth challenges. The eleven founding members are being joined by additional universities to define lower TRL research needs in 6 key theme areas and to advance projects that will support industry. The consortium is building strategic links with government, funders and the industry to determine how best to exploit university research and facilities to support sector goals. It is also engaging internationally to strengthen collaborations on research topics of common interest, in part through a secondment scheme that builds researcher connections and joint projects. The sector's net zero 2050 goal is a key driver for the UK-ARC community as it is for international researchers. The UK-ARC is growing as an inclusive academic resource to ensure that the crucial academic pillar of UK aerospace delivers maximum value to its stakeholder community.

Keywords: academia, collaboration, research, sustainability, strategy

1. Introduction

- 1.1 Delivering technology solutions for cleaner and quieter aviation is dependent upon collaboration in research. Aeronautics has its own academic research supply chain that builds and exchanges information on needs and solutions towards implementable products and practices. This paper explains how the UK-Aerospace Research Consortium (UK-ARC) [1] is using the power of interdisciplinary and inter-institutional planning and co-working to add a new dimension to research in aeronautics and aviation. It is a model that can benefit international research by bringing together researchers with a common purpose and also link with high level industry and governmental strategies and goals.
- 1.2 Aviation accounts for around 2.5% of global carbon dioxide (CO₂) emissions as well as being a contributor to other non-CO₂ emissions and these impacts will grow unless concerted action is taken. The value to society generated through air transport is under threat if new low and zero carbon technologies are not implemented rapidly. The UK-Aerospace Research Consortium (UK-ARC) is taking a whole system approach to understanding the optimal strategies for evolutionary and revolutionary technology development. The intent being that low and zero carbon solutions can be accelerated towards adoption.
- 1.3 The UK-ARC has initiated a number of research theme groups that look at needs and challenges in the areas of:
 - More Fuel / Energy Efficient Aircraft
 - Electrification
 - Hydrogen
 - Sustainable Alternative Fuels
 - Materials and Manufacturing and

- Air Transport

1.4 Research narratives in each of these theme areas are being developed, drawing upon UK-ARC academic expertise and that of other UK universities. These narratives which will account for and critique sector roadmaps will then be explored with the industry and operators, with government and organisations such as the Aerospace Technology Institute (ATI) and with international collaborators. The goal is then to define and undertake collaborative value-added and impact-driven research that assists and accelerates the aviation sector’s journey towards net zero operations. Although UK-ARC is UK focused, it aims to build relationships with international groups that are tackling the same problems. This paper sets out some of the developmental thinking and practical approach to delivering a ‘value-added’ research network.

2. Building UK-ARC

2.1 The UK-ARC formally started in September 2020 with the benefit of a network grant from the UK Environmental and Physical Sciences Research Council (EPSRC). Its core goal is to foster and promote excellent aerospace research. The consortium was founded with a grouping of eleven UK aerospace research intensive universities (shown below) and its underpinning aim is to realise the ‘greater than the sum of the parts’ principle through effective collaboration.



2.2 For understandable reasons, aerospace research within universities is often progressed through narrow industrial relationships and geographic ecosystems that are driven by competitive rather than collaborative behaviours. The UK-ARC is countering this tendency by drawing together academics across the consortium on different themes to determine research status and needs and to initiate new research. It is also providing a portal for the sector to access aerospace expertise. This is networking with a clear purpose as envisaged by the UK government when it endorsed the establishment of the UK-ARC through the Aerospace Sector Deal [2] as part of the UK Industrial Strategy in December 2018. This support recognised the need for better research alignment between industry and academia.

2.3 Whilst there is an established culture of collaboration between academics with a common interest, or between universities with some element of strategic alignment, multi-university partnerships tend to be geographically focused in order to secure collective economic advancement. The UK-ARC comes from a different mindset which is to build bottom-up group understanding and strategy development on research in a number of different needs-driven themes. It then seeks to build community level relationships between academics across boundaries and then to compare that view with the aerospace sector to build collaborations at the higher level.

2.4 The route chosen by UK-ARC to building broad academic groupings is to break down the overall research challenge into a number of theme areas that respond to the broad thrust of sector strategy. Current themes are:

More Energy efficient Aircraft

Hydrogen

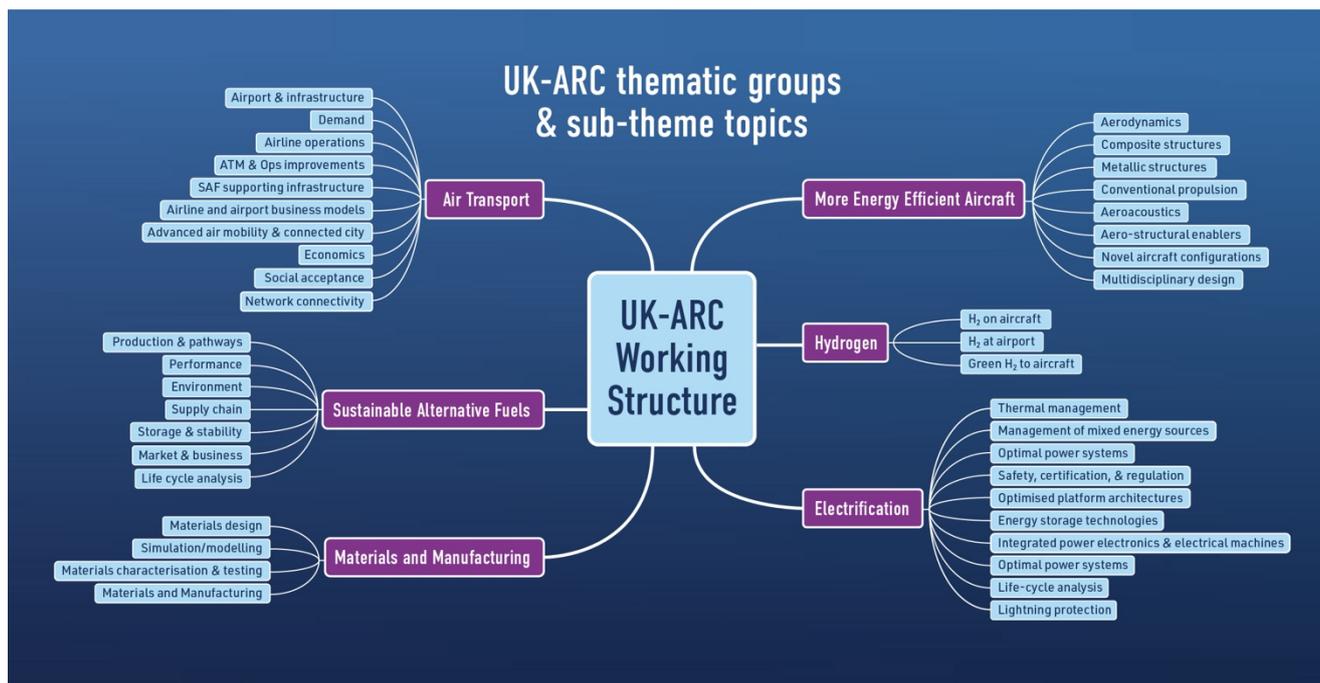
Electrification

Materials and manufacturing

Sustainable Aviation Fuels

Air Transportation

These themes are shown below with the numerous sub themes upon which research knowledge is being shared:



2.5 There are strong connections between all these themes which jointly represent the key challenges to delivery of cleaner aviation in the future. Accordingly, there will progressively be closer interaction between the themes to ensure complementarity, connection, and avoidance of duplication. These UK-ARC theme initiatives are intended to ensure an inclusive and comprehensive set of theme narratives and an overarching integrated viewpoint that can be discussed with the sector and government to ensure aligned research agendas. That relates not only to engagement within the UK but also internationally where there will be similar programmes of research needs analysis. The resulting output will represent a ‘blueprint’ for research that will accelerate adoption of net zero technologies and support industry ambitions.

2.6 It is expected that further themes may be added as the consortium matures and grows. An example is that of non-CO₂ emissions which connects the challenges facing the scientific, engineering, and operational communities. UK-ARC is already working to bring these communities together to help define the research steps needed to deliver answers on how to address upper atmospheric emissions of particulates, NO_x, and water vapour (from future hydrogen powered aircraft) and also the avoidance of contrails and induced cirrus clouds. Non-CO₂ emissions represent a challenge that is being picked up by government alongside the roll-out of SAF and accelerating technology advancement. UK-ARC therefore sees it as important to forge effective links to the science community, primarily those seeking to understand the upper atmospheric impacts of aviation but also with experts who are looking at the implications of change upon local air quality and health impacts.

2.7 There is strong common purpose, therefore, for academia to tackle these national and global challenge areas, in line with the UK government and industry goal to deliver net zero aviation by 2050. This is encapsulated in the work of the UK Jet Zero Council [3] which intends, amongst other things, to draw through technology and operational solutions to help meet climate goals. The Jet Zero Strategy [4] expressly notes that it is a collaborative venture between government, industry and academia and the UK-ARC is supporting its various groups.

2.8 In each of the UK-ARC theme areas which match with elements of this ambition, the theme

leads are building understanding of the breadth of research capability and activity across the UK-ARC universities and examining the gaps, weaknesses, opportunities, and priorities in the theme areas. Knowledge about the particular research facilities that each university hosts is being shared in order to foster inter-institutional project working. This information also helps to identify where there are needs for new or upgraded facilities to enable research and testing on new technology areas.

- 2.9 As the collective knowledge base develops, the consortium is working with the UK Aerospace Technology Institute (ATI) to explore the linkages and research needs both upwards and downwards. Good linkage across the Technology Readiness Levels (TRLs) scale is the objective. A notable example of developing industry/UK-ARC academic collaboration is through the ATI FlyZero project [5] which had the aim to realise zero carbon commercial aviation by 2030. Concluding in March 2021, Fly Zero drew significantly on academic, especially from the UK-ARC universities to source technical and operational fore sighting knowledge that is part of realising the 2030 goal - this work was summarised in the FlyZero academic report [6]. UK-ARC universities have undertaken more than a dozen studies for the FlyZero team characterising the status of emerging technologies, analysing roadmaps, and exploring optimal research pathways. This work is about accelerating the transfer of low TRL knowledge to help the aerospace sector strategise effectively and be able to make sound decisions about which technologies show greatest promise towards cleaner aviation. Understandably, there has been significant focus upon hydrogen and also electrification, but also upon structures, systems, the innovation approach, and noise. This process is helping to build the lower TRL research ecosystem and strengthen industry/ academia links. It is also helping to draw out new academic connections.
- 2.10 As a product of the research theme collaborations, a number of research proposal discussions are in hand to put forward research projects that pick up on multi-institutional viewpoints but also responds to a wide understanding of research need. If such work is to be truly fruitful, it needs to be based upon a multi-stakeholder position on research strategy, roadmaps, and proprieties. Accordingly, discussions with industry have led to the formation of the Strategic Aerospace Research Forum (SARF) which is a high-level collaboration between government, industry, academia, and funders. This initiative advanced jointly by the Aerospace Growth Partnerships(AGP), and the UK-ARC was launched at Farnborough International 2022 in July and flagged in the AGP's Destination Net Zero report [7]. The SARF initiative will enable sharing of knowledge and positions across four communities in order to gain agreement on research funding priorities.
- 2.11 In setting up the UK-ARC, it was always the UK government's intention to promote an academic community that is inclusive. Whilst the consortium has started with eleven members, it is already growing with many further UK universities contributing the work of the research theme groups. There are also formal discussions ongoing towards expanding membership beyond the founding members so that the UK-ARC captures the best expertise that is available across UK universities to support aerospace research and development. This means engaging not only the heavy-weight research-intensive universities with acknowledged aerospace and aviation expertise but also those with niche capability that can unlock new opportunities. Importantly, all UK-ARC universities will have multi-sectoral research relationships, expertise, and track-records. It is the intent of the UK-ARC to carry out as much knowledge transfer as possible with research teams working across non-aerospace sectors. Developments in hydrogen and electrification are key examples where there is much scope for cross-sectoral learning.
- 2.12 Researching the future technology landscape necessarily means that skills and talent needs are evolving in parallel. Whilst the initial focus of the UK-ARC has been upon identifying research needs, the consortium must also help to foster the next generation of engineers and

scientists. Spurring the development of new laboratories, training centres and PhD programmes aligned with industry needs is essential and this should include the development of international alliances.

2.13 Although the UK-ARC is fairly recently formed as a means to expand the value of the UK aeronautics and aviation academic community, its component parts are long-established and highly valued parts of the ecosystem. The consortium intends to build upon this track-record to support the aviation sector's goals, build the UK research ecosystem and to facilitate international collaboration.

3. International connection

3.1 Given that the international aeronautics research community has common purpose to deliver a sustainable future for the sector, strengthening links between international groups makes good sense. The UK-ARC is actively working to forge productive international connections that can multiply research funding value. This includes linkage with key European, US and Canadian representative institutions and groups. The UK-ARC is working to build these links with international academia, research organisations and representative groups on research agendas, strategies, and project collaborations. A number of countries have major aeronautics and aviation research communities and, in the nature of academic project collaboration, many of these will have established cross-border academic links through prior project work. There is clear value to UK and international stakeholders in industry and governments in cross-fertilising expertise and stimulating broader discussion. Across the world, academics are tackling the same issues in aviation and aerospace to achieve a sustainable and efficient future for the sector. The UK-ARC strategy is built around a 'climate neutral' research programme and other countries will doubtless share this focus.

3.2 The UK-ARC is also looking towards establishing new international research programmes where there is match-funding potential or by expanding engagement with programmes such as with the Horizon Europe, Clean Aviation programme of the European Union [8]. Collaboration has always been an enabler of such programmes and the UK-ARC believes that it can make a better international contribution by offering clarity on the UK research landscape, strategic alignment with industry goals and government programmes. It is also a route to identifying and engaging means the best experts for the critical research tasks required to support future aviation.

3.3 The UK-ARC has initiated a secondments programme as part of this international engagement thrust to link researchers at the academic working level and these are currently developing with French, German and US organisations. The aim is that these expert to expert connections will lead to the formation of research project collaborations and also to inter-group relationships between the UK universities and the hosting international organisations.

3.4 In line with the ethos of ICAS, the UK-ARC intends to disseminate research outcomes and, importantly, also information about the capabilities and facilities that exist within the consortium. That is part of good collaboration practice as well as helping to inform and educate future engineers and scientists. The UK-ARC will engage internationally to help promote coordination and maximise the potential for joint research activity. The maturing UK-ARC research narratives will therefore be used to help build cross-community consensus on the way forward.

4. Discussion and Next steps

4.1 The UK-arc is recognized as being a valuable addition to the UK aerospace landscape since its formation. As the linkages grow between this academic collective and the sector and government strategists, for instance through the SARF group, real benefits for aerospace will arise. The

development research theme narratives are being welcomed and there is now increasing focus on building engagement with aerospace universities through the UK-ARC.

- 4.2 As industry-aligned research projects progressively arise from the broad multi-disciplinary theme discussions within the consortium, more universities will join the UK-ARC. We intend that joint theme dialogues with industry should be undertaken through workshops and conferences to strengthen the connections, support cross-fertilization of expertise and exploit the use of facilities hosted by universities. Together with growing international linkages, these steps will yield the research advances needed to achieve net zero aviation.

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