Flight Paths of the Future?
Cranfield University AIRC

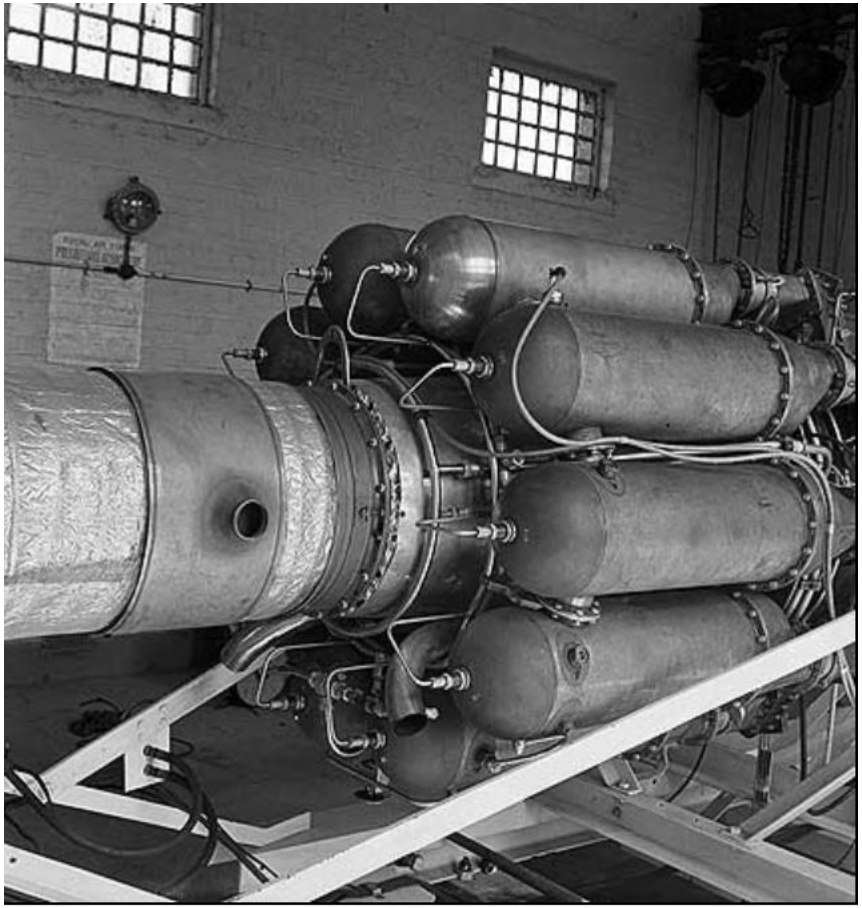
ISABE2017
23rd ISABE Conference






ISABE Conference
7th September 2017
Iain Gray, Cranfield University

Cranfield – College of Aeronautics est 1946



Today teaching and research as important as ever

What is the role of Universities

Teaching and Learning

High Level Apprenticeships

Continuing Professional Development

Executive education

Research ….

Improving productivity and competitiveness

Graduates with the right skills and mind-set to compete in the high-tech global knowledge economy.

Cranfield Airport and Runway – A unique asset ….

The only university in Europe with its own Airport and Runway

…. Ideal for demonstration of ground and flight concepts

Cranfield: a unique university

- Engineering, Science & Management
- Industry-focused, Industry-engaged, Transformational Research
- Exclusively Postgraduate
- Executive & Professional Development, Masters & PhD
  - > 4,500 Postgraduate students
  - > 800 Doctoral students
  - > 20,000 Exec & Professional Development
  - From > 100 countries

Cranfield has Distinctive Strengths

- Aerospace
- Defence and Security
- Energy and Power
- Environment and Agrifood
- School of Management
- Manufacturing
- Transport Systems
- Water



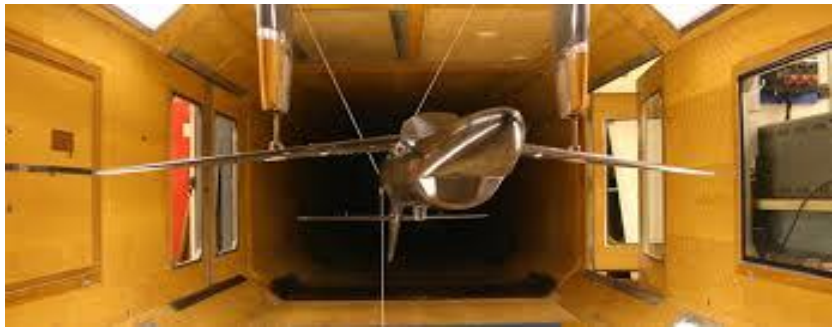





Extensive facilities:
Aerospace, Transport & Manufacturing

- Autonomous Systems Laboratory
- National Wind Tunnel Facility
- Icing Wind Tunnel
- Gas Turbine Test Area
- Aerostructures Assembly & Systems Installation Laboratory
- Rolls-Royce University Technology Centre (UTC)
- Aerospace Integration Research Centre (AIRC)
- Cranfield Aerospace Solutions

- also: Aerospace Technology Institute (ATI) based on Cranfield University Technology Park



Extensive facilities:
Aerospace, Transport & Manufacturing

- Cranfield Airport
- National Flying Laboratory Centre
- Boeing 737
- Accident Investigation Centre
- Mechatronics Laboratory
- Offroad Laboratory
- Intelligent Mobility Engineering Centre
- Multi-User Environment for Autonomous Systems Integration

Extensive facilities:
Aerospace, Transport & Manufacturing

- Centres for Innovative Manufacturing in:
  - Ultra Precision
  - Intelligent Automation
  - Through-life Engineering Services
- Surface Engineering Laboratory
- Engineering Photonics Laboratory
- Additive Layer Manufacturing and Welding Laboratory
- Virtual Reality Laboratory
- Composites

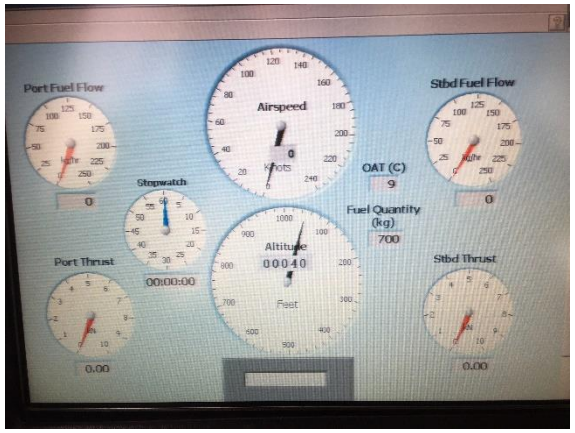
Cranfield Aerospace Education Example

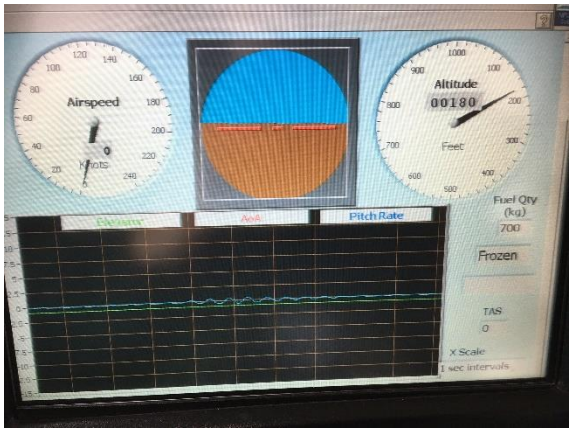
Cranfield's unique student experience,

flying students in our own instrumented aircraft

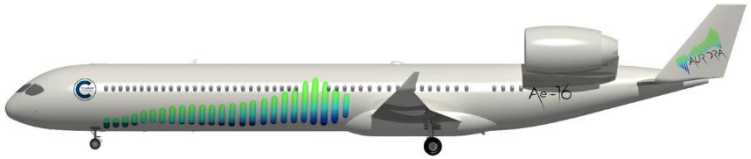
Cranfield operates a fleet of three aircraft

Aerospace students at Cranfield fly in our instrumented aircraft to learn about, and feel, flight and ground dynamics, behaviour and technologies

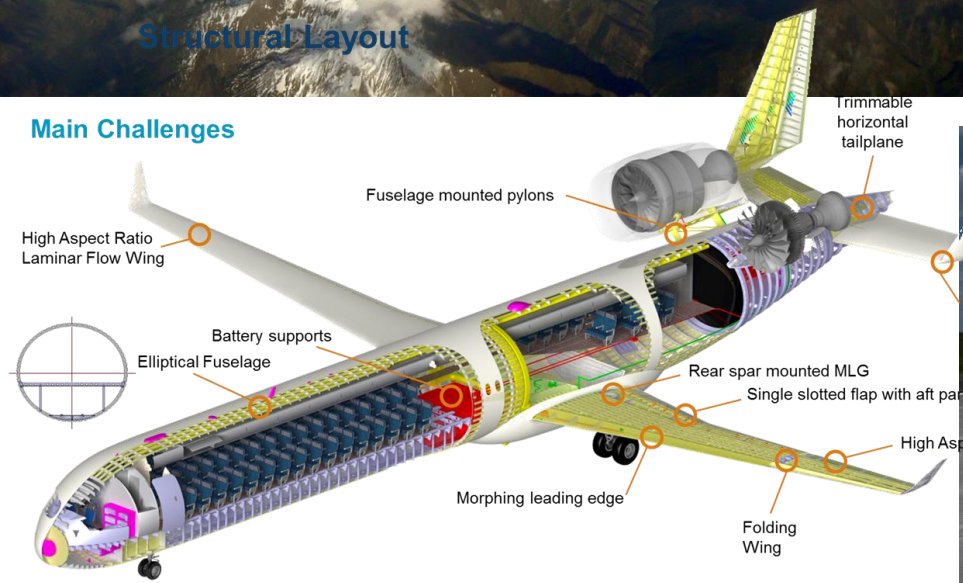




Cranfield Group Design Project Ae16

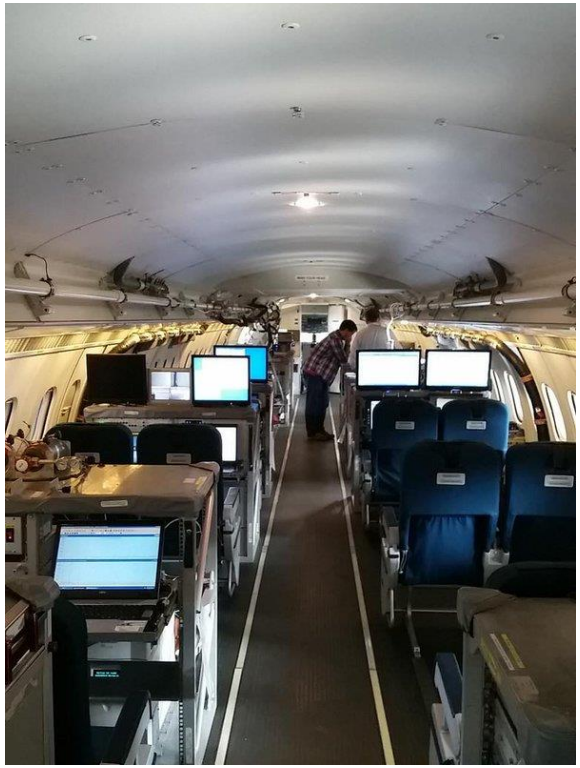


Main Challenges



Boeing 737-400 Ground based demonstrator

Cranfield University
Home Europe's foremost flying laboratory
FAAM 146 Research Aircraft

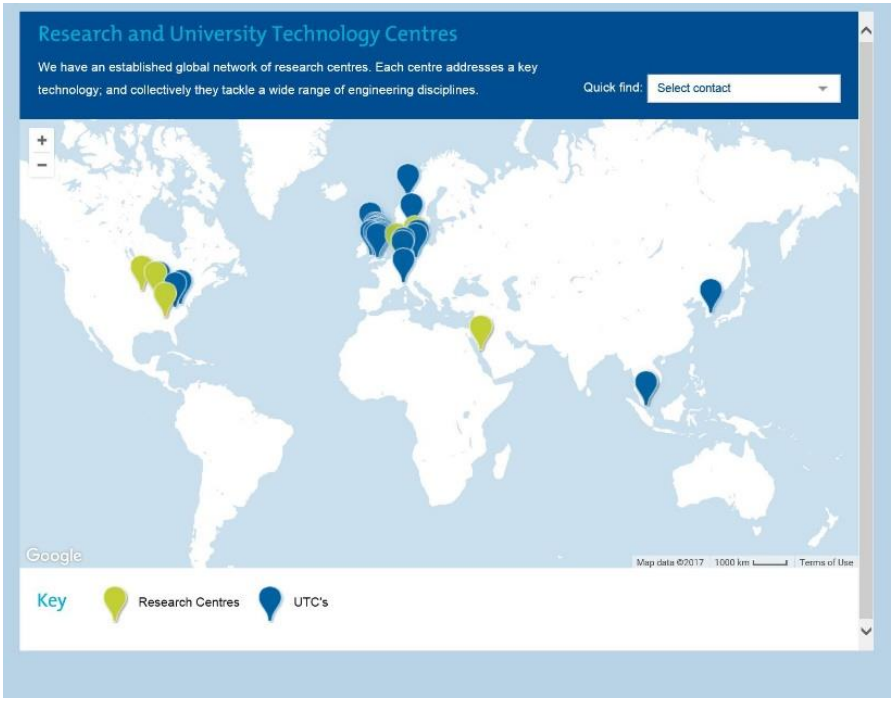


Gas Turbine Test facilities:

Analysis
Diagnostics
Energy and the Environment
Life Cycle Costs and Power
Propulsion and Power
Selection of Equipment
Simulation

Rolls Royce University Technology Centre UTC

- “Unlike our major competitors, Rolls-Royce does not have a large corporate research centre. Instead, we have made our selves totally dependent on our University Technology Centres for our future technology. Our global university partners more than rise to this challenge”
- Ric Parker, former Rolls-Royce Director of Research and Technology



Source Rolls Royce

The Rolls-Royce UTC at Cranfield

- **Industry-academia partnership since 1998**
- **From 'Performance' to 'Systems Design, Integration & Performance'**

"Core competence our ability to undertake detailed studies involving highly integrated, aero-thermal, multi-disciplinary models, to improve understanding of power plant and sub-system design, integration and performance in the context of the product's life cycle and mission."

The Rolls-Royce UTC at Cranfield

- **Rolls-Royce customers:**
  - ✓ System Design Global Function
    - Global Performance Function
    - Installations Aerodynamics
  - ✓ Engineering for Services
  - ✓ Systems Engineering
  - ✓ Future Programmes Engineering
  - ✓ Future Technologies Group
  - ✓ Marine
  - ✓ +++

- **Conduit for Rolls-Royce to place research work with other groups and departments at Cranfield (50+ projects since 2010 worth >£1.8M)**

- **Collaboration through EU-funded research**

- **Additional gearing through ATI, IUK, EPSRC and other funding sources**

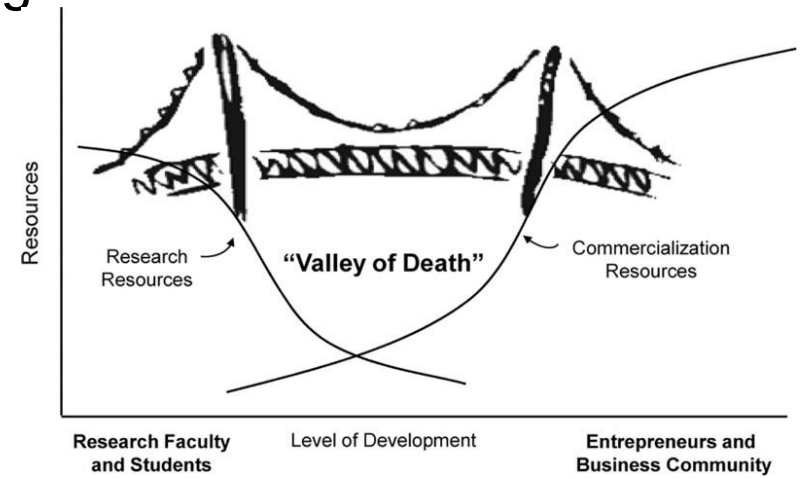
Aerospace Integration Research Centre

What is the AIRC?

- A £35m investment by Cranfield, HEFCE, Rolls Royce and Airbus
  - Encouraging collaboration between academia and industry
  - A unique research facility for integration of complex aerospace solutions
  - Operational since January 2017
- Capacity
  - Over 2000 sq m lab space
  - Secure office space for 60 permanent hot desks
  - Further collaboration space for 100+ people
  - Airbus and Rolls Royce Offices for 6-8 people
- Simulators and Vision
  - Flight and ATM simulator
  - Virtual wind tunnel facility being developed
  - Advanced visualisation/presentation suite used for intensive workshops

Greater readiness of research

- Facilitating route to commercialisation of research



- Achieving higher "technology readiness"
  - Greater integration of technology within system
  - More representative environments
  - Whole end-to-end processes rather than individual activities

Aerospace Integration Research Centre AIRC

- Addressing:
  - New and novel aircraft concepts with advanced power and propulsion concepts
  - Wider system integration with air transport management and business model integration

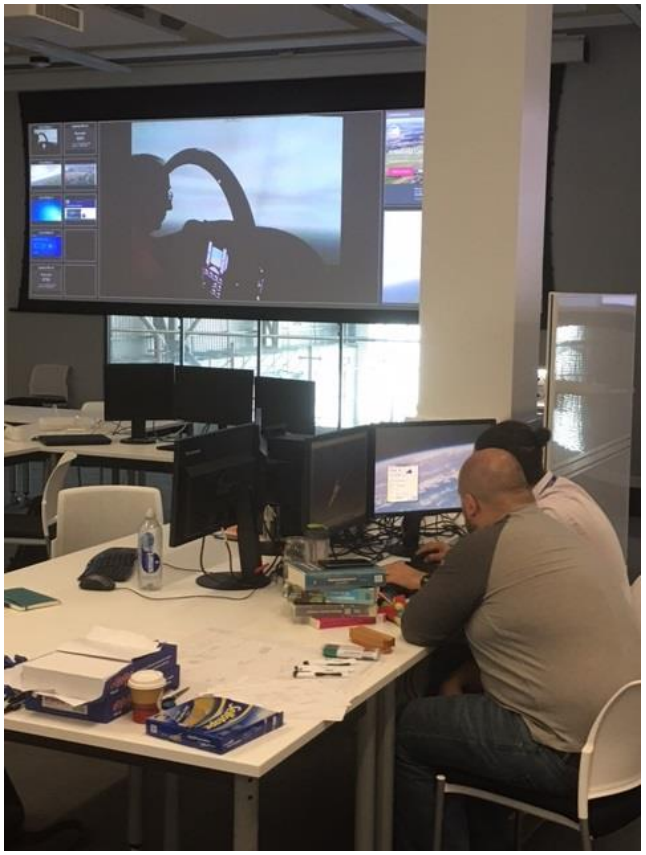
Greater integration of product

- Benefits from optimising the whole rather than just the parts
- Considering technology, process and business models
- Grand challenges
  - More efficient and effective solutions
  - Improved timescales and costs

Aerospace Integration Research Centre AIRC

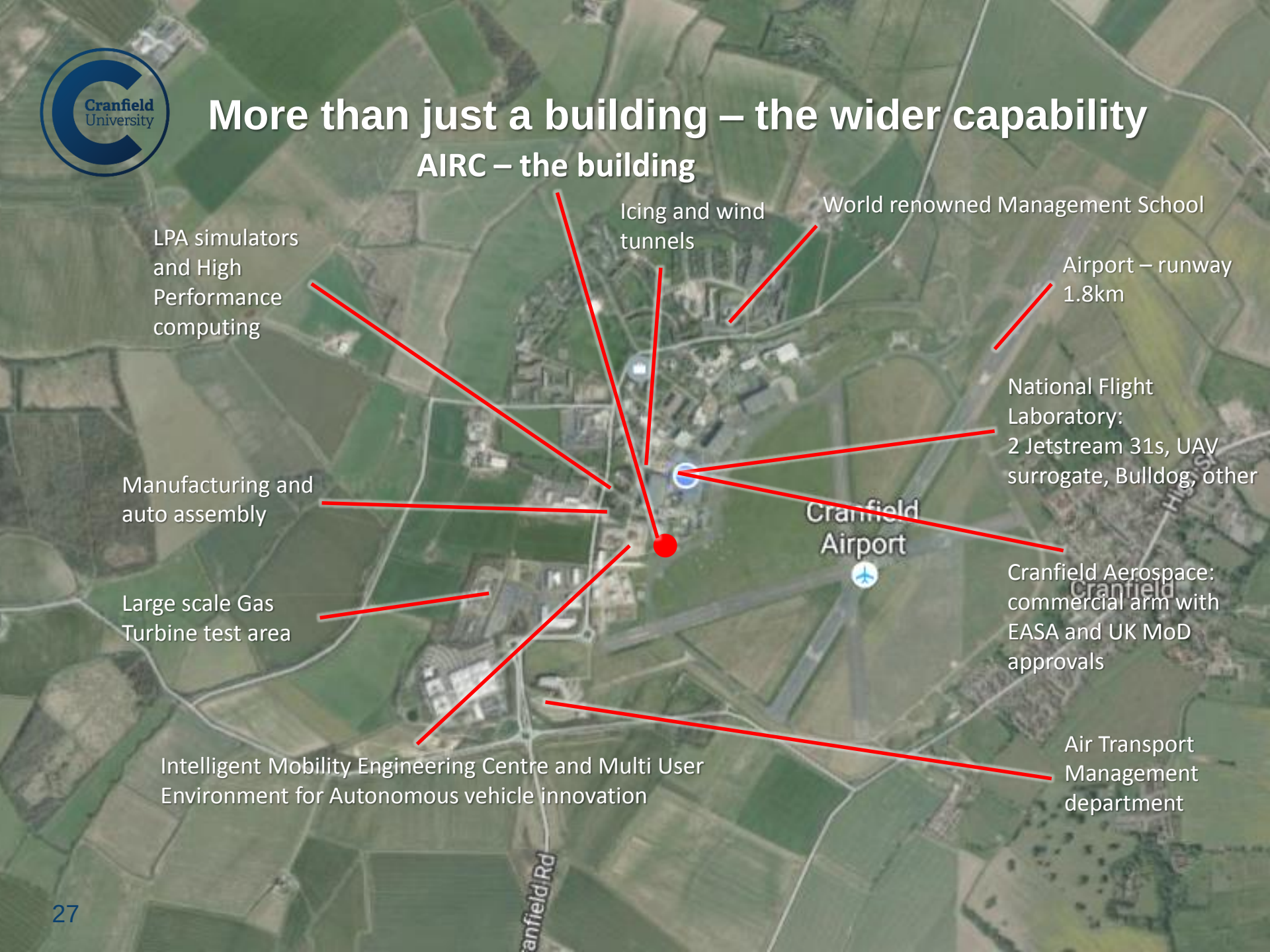
- IDEAS Space
- Large Open Lab
- Flight Simulator
- Air Traffic Management Lab
- Aerospace Autonomy Lab
- Intelligent Assembly Lab

Aerospace Integration Research Centre
IDEAS SPACE



More than just a building – the wider capability

AIRC – the building

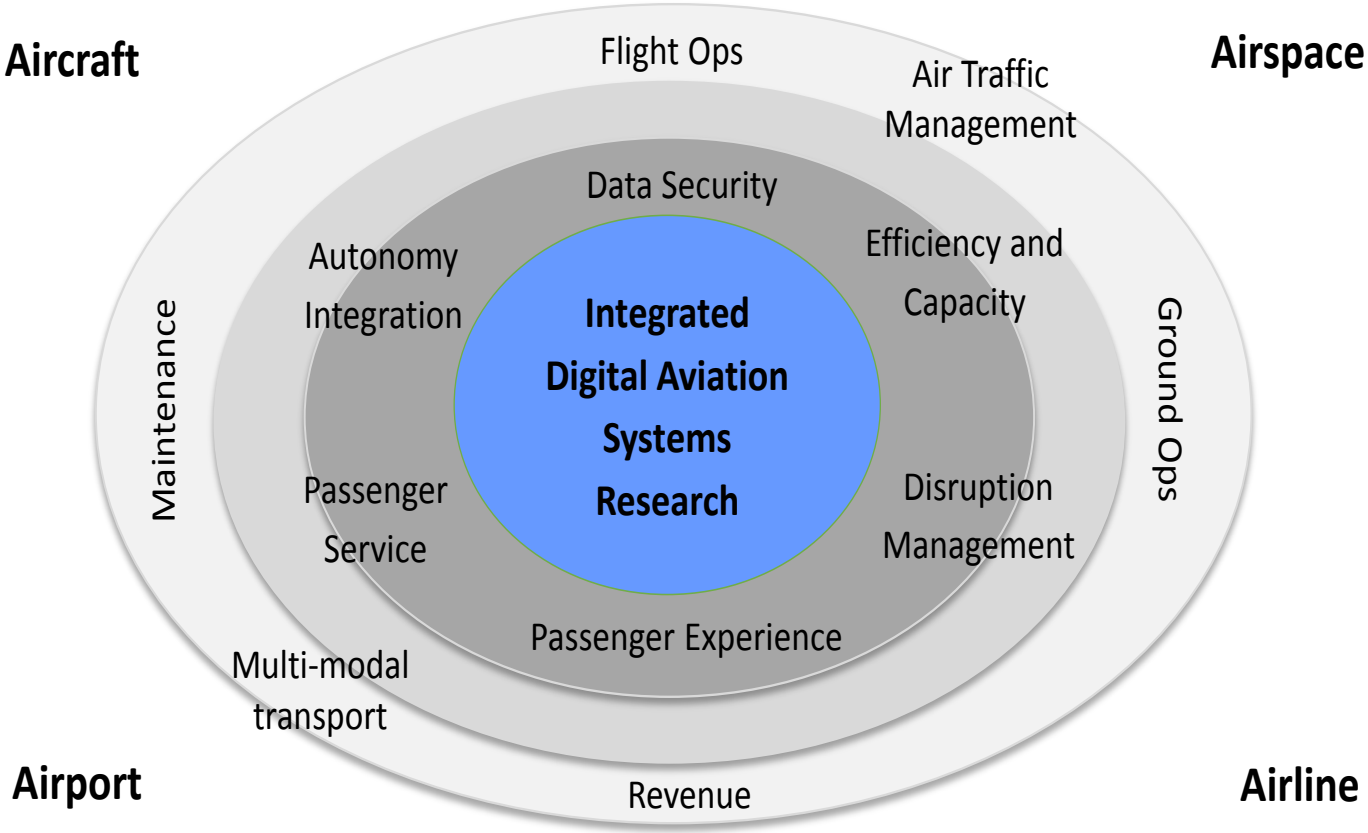


Concept of operation

- An integration environment - integration of distributed research across UK and wider
  - Surrogate airframer for Rolls Royce, surrogate component supplier for Airbus
  - Provide a neutral ground for exploration and experimentation
- Themes:
  - Aircraft/ propulsion of the future
  - Smart and connected aerospace solutions
  - Aerostructures of the future
  - High value design

DARTeC Value Proposition

Integrated Digital Aviation Systems Research



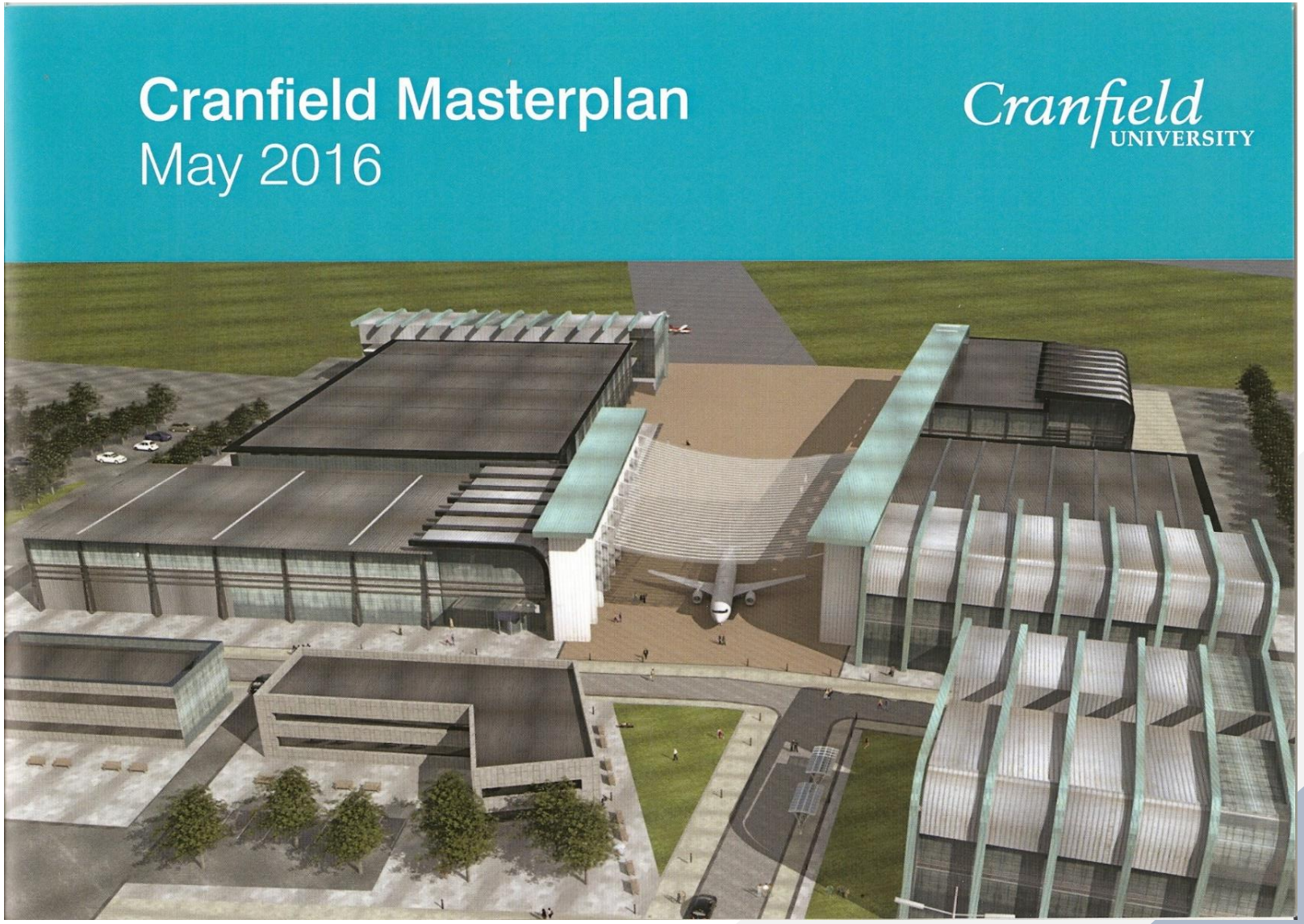
AIRC is the first step on a journey…

- Air vehicles of the future
- Airspace Management of the future
- Airline of the future
- Airport of the future

AIRC – Aerospace Integration Research Centre

DARTeC - Digital Aviation Research and Technology Centre

Cranfield's role …. Airport of the Future Masterplan



DARTeC Facility

Drawing together Cranfield's unique Assets, Capability and Experience to …

Establish a dedicated Digital Aviation Systems Research and Technology Centre (DARTeC) at Cranfield University to:

- Provide a technology demonstration and maturation environment (Physical + Virtual)
- Focus on the advancement of digital systems across the full aircraft + airport + airspace spectrum. .
- Address door to door passenger journey with focus on aviation elements
- Leverage both the Centre's assets plus those of the global Digital Aviation R&T sector to provide integrated technical and business systems solutions for accelerated market implementation
- Leverage UK and international research funding initiatives to scale up Digital Aviation Research and Technology Development activities

737-400 Flying Demonstrator

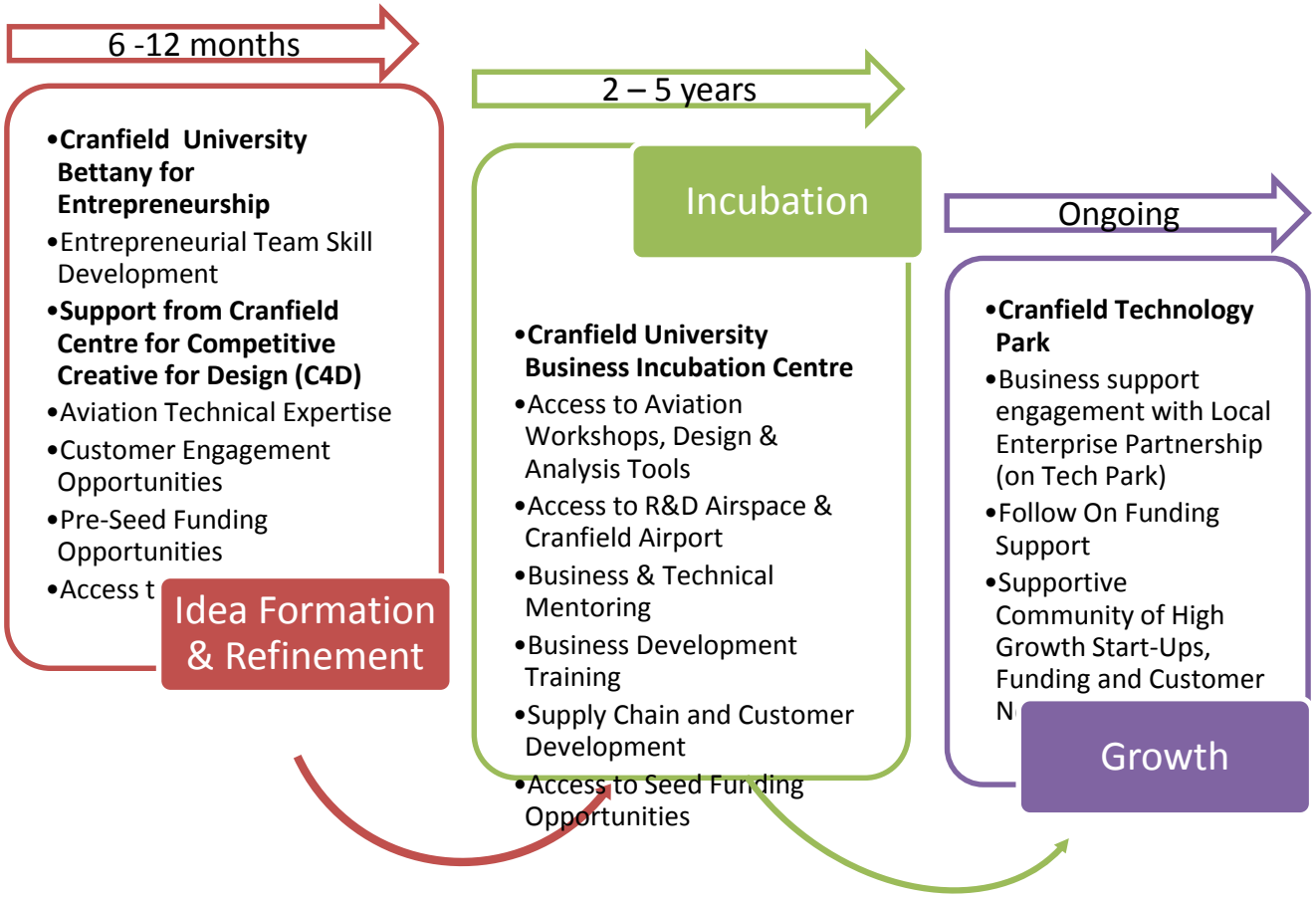
Research Hangar Lab

Access Operational Airport

Radar Enabled Research Airspace

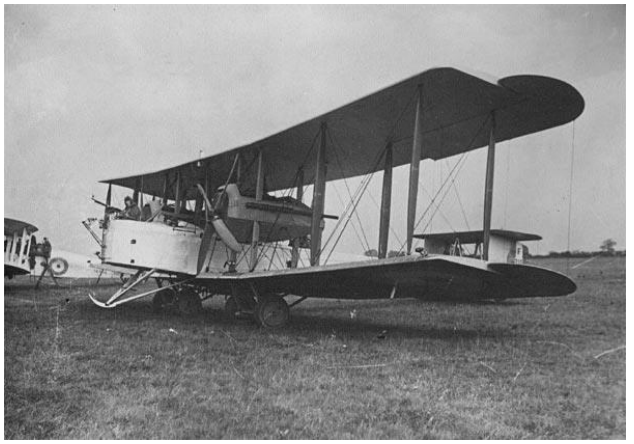
Reconfigurable Digital and Physical R&T Labs

Cranfield Aviation Accelerator



Satavia : The global leader in digital environmental intelligence

What does the future look like?



- We are on the cusp of a 3rd Revolution in Aerospace

- No one organisation can do everything – new ways of working with partners across globe being established

- Cranfield can play a key role.

http://www.wired.co.uk/article/airbus-flying-car

Trigger points for ACARE change .....

Increase extent of inter-disciplinary within and outside classical aerospace

New system concepts, e.g. more electrical flying

RPAS / UAS development and market take-up quicker than initially anticipated

Change in light of new technologies

New materials and manufacturing processes vital for manufacturing industry

Dynamic developments in the field of IT, e.g. big data, automation, digitalisation and virtualisation

Systems Integrator at research level
FLAVIIR Subscale Demonstrator

The BWB concept

NASA-Boeing X-48C blended wing body technology demonstrator awaits its first flight from Rogers Dry Lake on a hot August morning at Edwards Air Force Base, Calif

Jetstream - ASTRAEA
First surrogate ‘unmanned’ flight in civil airspace

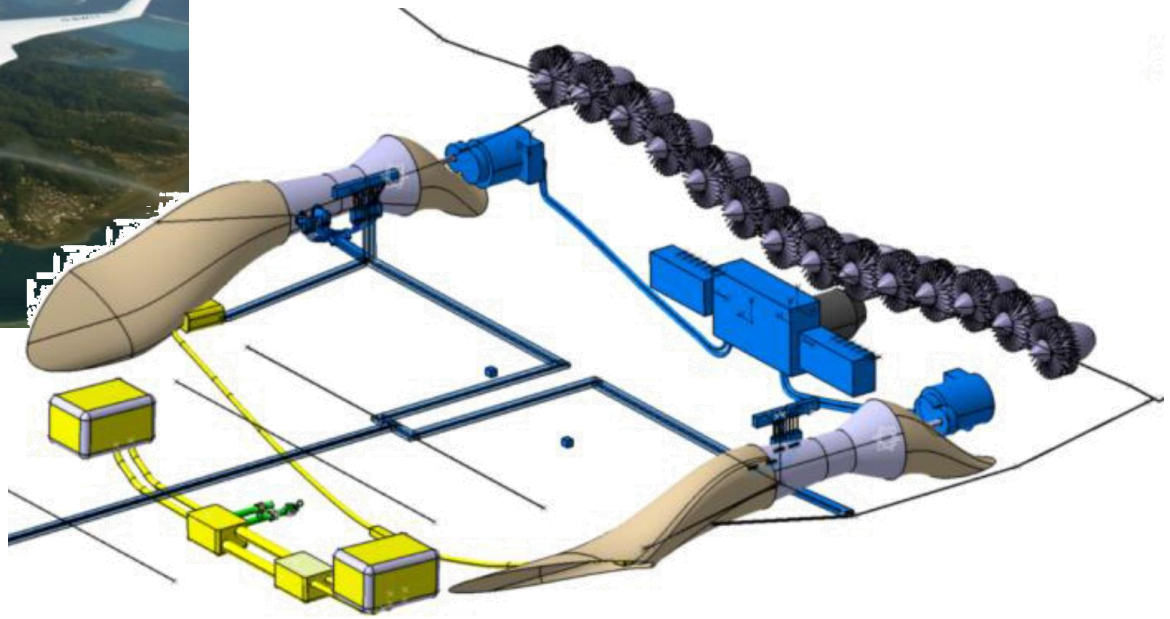
Development of electric aircraft?

All Require Demonstration

Can this be a scaled technology vision?

Reference ..Peter Malkin IET Lecture 2016

Hybrid electric benefits – Opens up more design freedoms



Source Howard Smith Cranfield University

What does the future look like?

We are on the brink of a revolution in aerospace
Cranfield University AIRC is helping to shape it