DISPURSAL

Distributed Propulsion and Ultra-high By-pass Rotor Study at Aircraft Level

Funding: European (7th RTD Framework Programme)
Duration: Feb 2013 - Jan 2015
Status: Complete with results
Total project cost: €788,536
EU contribution: €591,300

Call for proposal: FP7-AAT-2012-RTD-L0
CORDIS RCN : 106446

Background & policy context:
The objectives defined in Flightpath 2050 as well as the limited availability of fossil fuels call for significant reductions in fuel consumption in the air transport sector. Novel propulsion concepts are thus a field of intense research, with particular trends that emerge: hybrid energy sources may not only be more efficient, but open up new degrees of freedom in terms of airframe-engine integration. The power plant system can be fully or partially embedded in the airframe, and thus exploit the benefits of boundary layer ingestion and wake filling, which have proven to allow lower power requirements. However, despite the established advantages of such integrated propulsion concepts, little effort has been expended to examine the practical implementation in realistic aircraft systems.

Objectives:
The project DISPURSAL investigates the impact of novel propulsion concepts in a holistic manner, covering the aspects of power generation and drive chain architectures as well as engine-airframe integration together with the impact on aircraft performance and emissions.

Methodology:
The project is set up around two case studies, namely:

- A distributed propulsion concept with multiple propulsive devices
- A propulsive fuselage concept featuring a propulsive device encircling the fuselage.

Starting from the definition of realistic operational and systems requirements, initial concept exploration and down-selection define a baseline and feed into a multi-disciplinary design optimization process, which quantifies the efficiency potentials at aircraft level. Detailed numerical flow simulation is used to evaluate the strong interaction of airframe and propulsion. DISPURSAL shows the potential of distributed propulsion and highlights synergy effects with turbo-electric aircraft architectures. A technology roadmap derived in the project will contribute to establish distributed propulsion as a serious option for future air transport and sustain the competitiveness of the European aviation industry.

Parent Programmes:
FP7-TRANSPORT – Transport (Including Aeronautics) - Horizontal activities for implementation of the transport programme (TPT)

Institute type: Public institution
Institute name: The European Commission
Funding type: Public (EU)

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EU Contribution: €232,232

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EU Contribution: €60,520

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EU Contribution: €127,082

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EU Contribution: €171,466

Technologies:

- Aircraft design and manufacturing
- Hybrid wing blended body

Development phase: Research/Invention

- Aircraft propulsion
- Aviation hybrid electric powertrain

Key Results:
Propelling planes into the future

Enhancing the efficiency of propulsion can reduce fuel consumption and emissions in the air transport sector. Novel concepts such as multiple distributed propulsion systems and integration of propulsion into the airframe could help achieve goals.

Decreasing the environmental impact of flight is a pillar of the EU's research agenda. Hybrid energy sources are among the novel propulsion concepts shown to decrease power requirements and thus fuel burn and emissions. Concepts include distributed propulsion with multiple propulsive devices or a propulsive fuselage in which the power plant is fully or partially embedded in the airframe.

The EU-funded project http://dispursal.eu/ (DISPURSAL) (Distributed propulsion and ultra-high by-pass rotor study at aircraft level) implemented potential solutions in realistic aircraft systems. The team focused on two novel designs that take advantage of wake filling and boundary layer ingestion (BLI) commonly used in torpedoes, missiles and ships. The technologies are targeted for entry-into-service in 2035.

The distributed multiple-fans concept (DMFC) is a hybrid wing body with multiple BLI fans on the upper side of the fuselage. The propulsive fuselage concept (PFC) integrates an aft-mounted BLI fan that encircles the fuselage and is powered by a gas turbine in the fuselage aft cone. The design also includes two modern and fuel-efficient (ultra-high by-pass ratio) turbofan engines under the wing for redundancy.

Scientists evaluated component architectures, airframe-propulsion integration issues, powertrain system design and overall impact on aircraft performance and emissions. Concepts were compared to two other aircraft. The 2035R was a conventional gas turbine whose performance was projected to year 2035 and the SoAR was a year 2000 datum A330-300 aircraft. Advanced flow field simulations supported experimental work.

The DMFC and PFC both demonstrated significant improvements in fuel burn and carbon dioxide emissions compared to the SoAR and smaller but important ones compared to the 2035R. Outcomes highlighted the need to lessen the negative effects of BLI to meet emissions reduction targets, but showed that both are likely to meet noise targets for 2035.

Results were widely disseminated in scientific journals and via invited presentations at conferences. In addition, a model of the PFC was exhibited at one of the most important international aerospace conferences, the 2014 ILA Berlin Air Show.

DISPURSAL demonstrated the benefits of hybrid propulsion concepts and provided a roadmap for further optimisation. Eventual concept implementation could help the EU meet its stringent goals for eco-friendly flight.

Documents:
- Final Report Summary - DISPURSAL

STRIA Roadmaps: Vehicle design and manufacturing
Transport mode: Air transport
Transport sectors: Passenger transport
Transport policies: Decarbonisation, Environmental/Emissions aspects
Geo-spatial type: Other