AIAA/IEEE Electric Aircraft Technologies Symposium EATS
Students Design Challenge 2022-2023
Call for proposals

HELP AVIATION INTO A CLEANER FUTURE

INTRODUCTION

Since 2007, aviation's impact on climate change has been an increasing concern, principally focused on noise emission and CO2 emissions from the combustion of jet fuel. Advanced hybrid vehicle propulsion systems are very promising technologies for significant fuel consumption reduction and for reducing emission, without compromising vehicle performance (safety, comfort, flight envelope, etc.). Thinking of powertrain design, there are many trade-off challenges for the designer tackling the combined problem of energy management and electrified powertrain. In this spirit, the challenge for this year student competition is to find a holistic approach for electrified powertrain design, known to involve simultaneously a burdensome number of strongly coupled variables.

CHALLENGE

QUESTION = With the goal of consuming less fuel and emitting less noise, design a hybrid powertrain (*e.g., Serial-Hybrid, Parallel-Hybrid, Powered by Hydrogen Fuel Cells, …*) retrofitting a Dornier/RUAG Do 228NG aircraft (19PAX) as an alternative aircraft to fly on an existing route from Boston (BOS) to New York (JFK). Estimation of CO_2 emissions and noise emissions should be performed for your design and compared with the conventional Dornier 228 aircraft.

SPECIFICATION

- Reference Commuter Aircraft: Dornier/RUAG Do 228NG*
  - PAX 19 PAX
- Flight Route: BOS to JFK, see Figure 1 (https://flightplandatabase.com/plan/58633)
- Mission profile as given in Figure 2.
- Component technology for Entry in Service by 2030 .

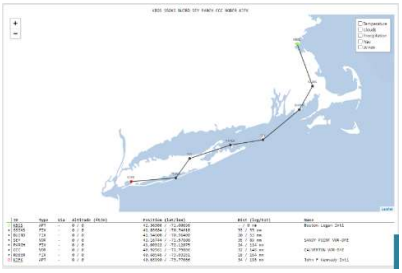

Figure 1 Flight route Bos-JFK, https://flightplandatabase.com/plan/58633

For more information on Dornier 228 see following references:

- 1) RUAG Aerospace Services GmbH, "Dornier 228 Advanced Commuter (AC) Facts & Figures," Wessling, Germany, 2015;
- 2) Dornier GmbH, Logistic, Pilot's Operating Handbook Including the LBA Approved Airplane Flight Manual - Dornier 228- 100, Munich, Germany: Dornier GmbH, 1983 https://rgl.faa.gov/Regulatory_and_Guidance_Library/rgMakeModel.nsf/0/5fdde13eb0864a9c862572a4006b8a64/$FILE/A16eu.pdf
- 3) Engine Honeywell, "TPE331-10 Turboprop Engine Brochure," Honeywell Aerospace, Phoenix, TX, USA, 2016.

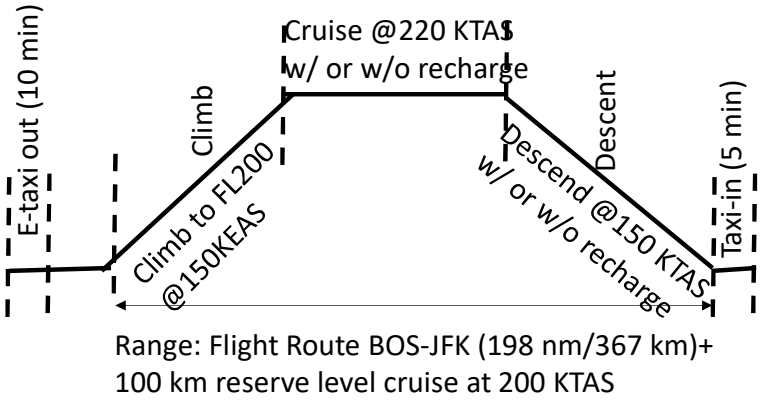

Figure 2 Electrified aircraft Mission Profile

INFORMATION TO BE PROVIDED BY THE TEAMS

- Given the above mission profile, a general architecture of the power distribution for propulsion, from the energy source to the loads (e.g. electric motors), through power converters, electrical wiring system, and protection devices;
- Performance of the reference aircraft configuration and its retrofit including one-engine-inoperative operation.
- A sensitivity study, in order to define the network voltage that is optimal, according to your calculation, and the impact on all components of the power chain, in particular the mass. Please detail how the voltage affects the mass of wiring cables and connectors, the cables and insulation thickness and mass, the choice of switching components in a converter and the converter topology. You should also discuss the voltage waveform (DC, AC and frequency, PWM and frequency) in the power chain.
- A safety analysis, which describes the failures that are taken into account in your design, how the network design is fault-tolerant with respect to these failures, and how fault propagation is mitigated.
- Batteries: please provide your assumptions on the technology, the energy, and power densities, including the integration factor (i.e. the ratio of the power and energy density at cell level and full battery level).
- Issues linked to hybridization, indicate how you intend to mitigate them: the physical laws and/or design rules that you are using.
- Method use for CO2 emissions estimations
- Method use for noise estimations

Aircraft Design Consideration:

- General description and architecture of the aircraft: length, span, shape, number of wings (if any);
- Type and number of propulsors (e.g. fans (ducted or unducted) or propellers, with or without pitch control, or collective and cyclic control for a rotor, if used)
- Description of how the electric power train is integrated in the vehicle (including energy storage and its source up to the propeller, total losses and how the heat is managed, etc.). *Component weight breakdown for the operative empty mass and maximum take-off mass.*

Electric Propulsion System Design:

- What system for power generation? Provide mass, power, volume, voltage, operating temperature;
- What system for energy storage? Provide mass, energy, volume, operating temperature;
- Electrical power distribution system
- System Safety Assessment approach: Considerations for Engineering Failure Modes and Effects

Concepts of Operation to meet the aircraft and electrical system design:

- Flight Management: On-board Flight Deck Crew, Remotely Piloted or Autonomous?
- Operating limitations

For all presented figures, the following data shall be provided:

- Details of the calculations made, hypotheses and justification (example: energy density of batteries);

Keep in mind that the answer to the question is not unique, and creativity is very important in your proposal. Moreover, what is important is to clearly explain:

- The hypotheses and assumptions that you are taking,
- Their justification (literature survey including scientific references is strongly recommended),
- The methodology and tools that you are adopting for solving the problem,
- The limits of validity of some hypotheses or calculation.

SUBMISSION AND RANKING

The Proposal shall be a written report in English of 30 pages maximum. It is not mandatory to have a hardware demonstrator. A video with a maximum of 5-minute duration can be submitted with the proposal. Every proposal will be evaluated by a jury panel, according to the following ranking:

- Originality (25 points)
- Technical content (25 points)
- Feasibility (25 points)
- Report quality and clarity (25 points).

ELIGIBILITY

- More than one design may be submitted from students at any one school. Teams can consist of the following:
- Undergraduate students
- Graduate students
- Combine Undergrad and Graduate students

SCHEDULE

- October 3, 2022 – Submission opens
- Feb 1, 2023 - Teams submit a Letter of Intent (LoI)
- May 15, 2023 – Submission deadline
- June 1, 2023 – Winner announcement
- June 14-16, 2023 – Awards at EATS

Website for submissions: http://bit.ly/2023EATSStudent

PRIZE

Monetary Award: 750$ 1st prize, 500$ 2nd prize, 250$ 3rd prize

COPYRIGHT

CONFLICT OF INTERESTS

It should be noted that it should be considered a conflict of interest for a design professor to write or assist in writing RFPs and/or judging proposals submitted if he/she would have students participating in, or that can be expected to participate in those competitions. A design professor with such a conflict must refrain from participating in the development of such competition RFPs and/or judging any proposals submitted in such competitions.

SUGGESTED PAPERS

- Performance Analysis of a Hybrid-Electric Retrofit of a RUAG Dornier Do-228NG https://aircraftperformance.software/files/DLRK_2017_Juretzko.pdf
- A Comprehensive Approach to the Assessment of a Hybrid Electric Powertrain for Commuter Aircraft (DOI: 10.2514/6.2019-3678) https://arc.aiaa.org/doi/pdfplus/10.2514/6.2019-3678?Site=aiaa_frame
- A Comparison of Hybrid-Electric Aircraft Sizing Methods (DOI:10.2514/6.2020-1006) https://pure.tudelft.nl/ws/files/68466812/6.2020_1006.pdf
- Gokcin Cinar et. al, Modeling and Simulation of a Parallel Hybrid Electric Regional Aircraft for the Electrified Powertrain Flight Demonstration (EPFD) Program, DOI: 10.1109/ITEC53557.2022.9813832, https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9813832