2022 CASE STUDY COMPETITION

Student competition around a case study in aerospace organized as part of the "Vitrines 2022" event

PROPOSE A SERIES OF OPERATIONS TO SUPPLY AIRCRAFT POWERED BY MORE SUSTAINABLE ENERGIES THAN CONVENTIONAL KEROSENE.

Theme

Sustainable development in aviation: enable efficient aircraft refueling at airports while considering the emergence of clean energy (clean and sustainable fuels (SAF), hydrogen and electricity) as a source of energy for commercial aircraft propulsion that can carry up to 100 passengers for a domestic Montreal-Toronto flight departing from Montreal-Trudeau Airport.

Introduction

Accounting for nearly 2.1% of global greenhouse gas (GHG) emissions, air travel is a significant contributor to global warming. [1]. To perpetuate sustainable development, international goals, such as the Paris Agreement, have been set, calling on industry to think and design "greener" commercial aircraft, i.e. aircraft that emit less greenhouse gases during their use, consume renewable energy and are manufactured in a responsible and sustainable way.

Currently, the main ideas explored to significantly reduce the negative environmental effects of commercial aircraft focus on the improvement of their weight, aerodynamics, the implementation of a green supply chain management (GSCM) or the use of "green" energy for their propulsion, this final one being an increasingly popular solution in research and development (R&D).
This case study focuses on the latter solution, which is already being implemented in the form of clean and renewable fuels – commonly referred to as SAF ("sustainable aviation fuels") – used to propel some short-range flights.

The implementation of the new energy sources presented so far requires a lot of work on the aircraft themselves, but a lot of work needs to be done to **overcome the logistical challenges that the use of alternative energy sources could bring to airports**. Airports are currently optimized to refuel kerosene aircraft in a minimum amount of time, and optimizing them to refuel non-kerosene aircraft may require investments in time and money as well as a variety of manpower, including engineers, architects, logistics experts, infrastructure planning, etc.

Current situation: Aircraft refueling with kerosene at the Montreal Airport [Scenario 0]

Currently, airplanes landing at Montreal Airport (YUL) have only one choice of fuel: kerosene. Jet fuel is brought to the airport in the form of Jet A and Jet A-1 fuel through a pipeline run by the Montreal International Fuel Facilities Corporation (MIFFC), allowing the airport to be supplied without the need for a network of tanker trucks travelling from the refineries to the airport.

Once the fuel arrives at the airport, it is stored in underground tanks that can hold a vast amount of fuel. This type of storage requires daily testing to ensure that no mold or mildew forms in these tanks. Fuel that successfully passes this test can then be used for refueling aircraft tanks through the use of pumps. It should be noted that an alternative to pumping and therefore to refueling by pipeline is the use of tanker trucks directly serving the aircraft concerned (usually of smaller size).

At least two employees are needed to refuel the aircraft. For larger aircraft, an elevator is used to connect the pumping hose under the wings, while for smaller aircraft a simple step ladder is sufficient. Of course, a technician must handle the aircraft to bring it to the pumping stations and no passengers may be on board the aircraft during refueling.

The following plans allow you to better understand how the airport is laid out. We can see the different refueling and parking areas for aircraft during this procedure.

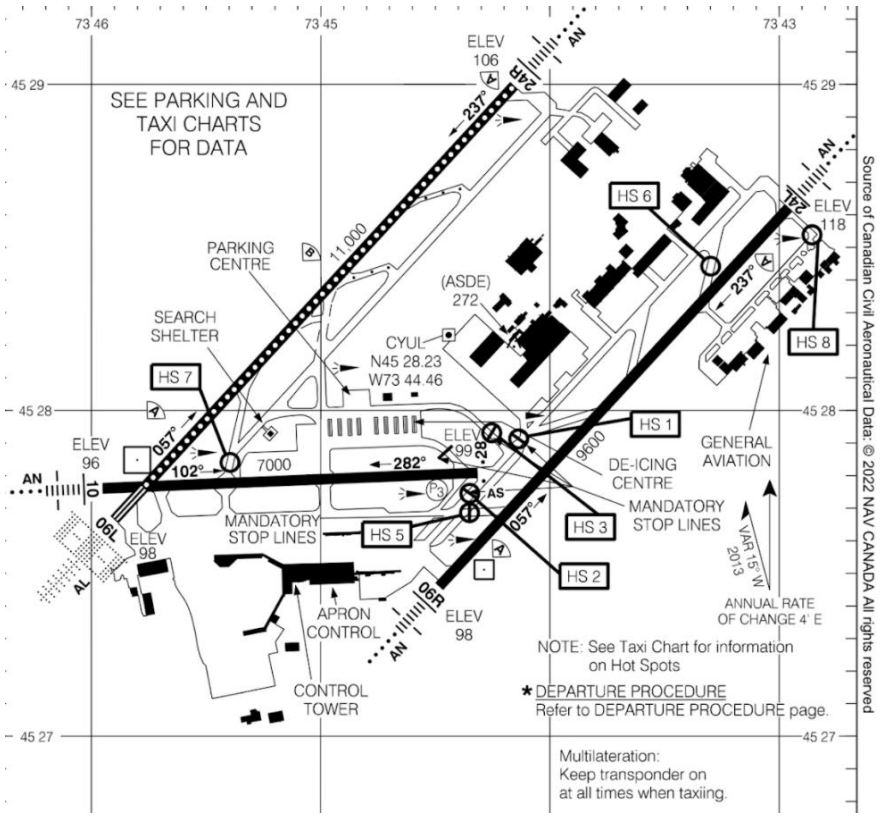

Figure 1 – Map of the Montreal Airport

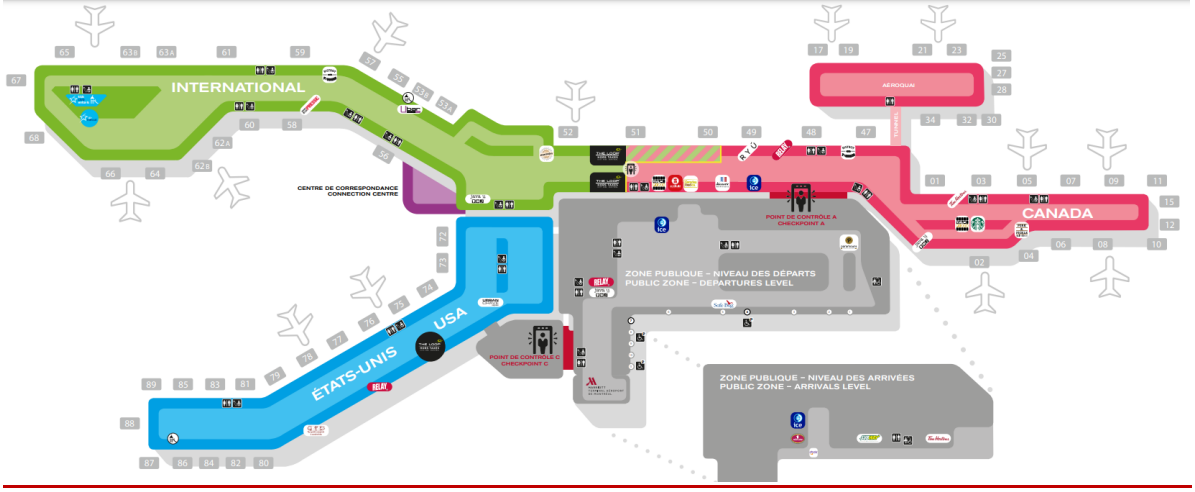

Figure 2 – Departures map

Source : https://www.admtl.com/fr/plans-imprimables

Objective

Rethink refueling operations for a commercial aircraft powered by green energy and compare these new operations to those currently implemented for kerosene aircraft refueling.

Given the possible transition to green energy alternatives in a few years, you are asked to design and propose a fast and efficient refueling process for aircraft powered by one of the following propulsion modes:

1. **Propulsion by electric motors powered by batteries (15% electric, either battery electrics packs or hydrogen fuel cells) [Scenario 1];**
2. **Propulsion by traditional OR electric engines powered by compressed, cooled hydrogen or liquid hydrogen (25%) [Scenario 2];**
3. **Propulsion by traditional engines with SAF only (without kerosene) [Scenario 3].**

Special attention will be paid to the technical feasibility and universality of the proposed solution. Thus, the proposals made must allow simple and efficient logistical operations. Considering the considerable difference in accessible documentation between scenario 3 and the first two, a more detailed and precise analysis is expected from the teams that select scenario 3.

Participation rules

Teams entering the competition will be required to adhere to the following rules:

1. Participants must be students enrolled in CEGEP or university at the 1st, 2nd or 3rd cycle in Quebec;
2. Teams must be composed of 2 to 4 people.

Note that a bonus point will be awarded to multidisciplinary teams. It is therefore advisable to compose your team with members from at least two different disciplines (e.g.: engineering, administration, science, aircraft maintenance, marketing, materials and composites, …). The selection of finalists will be based on the quality of the application submitted in the first stage of the selection process. An evaluation grid can be found later in this document.

Deliverables for the selection phase

Each team is expected to submit a text, in French or English, with a minimum of three elements:

1. justification of the scenario choice,
2. presentation of the solution, and
3. comparison of the solution to the scenario 0.

1. The chosen scenario (1, 2 or 3) must be clearly identified in the introduction and the justification must take into account future developments in the aerospace sector as well as the interests of the team members. Originality and relevance will be evaluated for these two sections.

2. In the solution presentation section, **at least three of the following items** should be addressed, in addition to the description of the proposed solution and the environmental impact of the implementation of your solution:

    - Profitability (marketing advantage, profit, etc.);
    - Cost and development time;
    - Technical feasibility;
    - Safety and reliability;
    - Certification challenges.

3. In the comparison section with scenario 0, two of the three following elements must necessarily be addressed: **environmental impact**, **cost effectiveness** and **safety and reliability**.

This comparison should be made not only with the elements presented in this document, but also with data found in your own research. It is also possible to detail your solution in relation to elements other than those presented if you consider them relevant to your study and to compare your solution to scenario 0 in relation to them. Please note that the final file must be submitted as a PDF document (from 4 to 8 pages, excluding appendix) and must include, in addition to the sections previously requested, a short introduction and conclusion. Your conclusion must propose future projects that you think the Québec aerospace industry should focus on to ensure sustainable development

Evaluation grid for the selection phase

CRITERIAS	DESCRIPTION	SCORE
Justification of the choice of scenario	• Is the justification clear and precise? • Is it based on facts? • Is it based on personal values and ideas?	/4
Presentation of the solution	• Is the solution technically feasible? • Does it allow for simple and efficient logistics? • Is the environmental impact well considered? • Are at least 3 of the expected elements detailed?	/7
Comparison of the solution to scenario 0	• Is the comparison based on relevant facts? • Is there a variety of items for comparison? • Are content constraints met?	/5
Quality of presentation and answers to questions	• Is the presentation professional? • Does the conclusion point to relevant research for the Quebec aerospace industry? • Is the bibliography complete?	/4
TOTAL		/20

+1 bonus point will be awarded to multidisciplinary teams

+ 2 bonus points will be awarded to teams that analyze scenarios 1 or 2

Course of the competition

The competition is divided into two distinct phases:

1. Receipt of answers to the case study by email at aeroportail@aeromontreal.ca by April 25, by 11 am;
2. Selection of the three finalist teams by the jury;
3. Finalists presentation to the jury during the "Vitrines 2022" event; at Montreal Sciences Center;
4. Announcement of the winning team on May 7 at around 4:30 pm and prize ceremony.

Note that all teams will receive feedback on their work, whether they are finalists or not.

Prizes

All participants will receive the following prizes, while supplies last:

- Quebec Aerospace Museum (QAM) membership cards;
- Tickets for the Cosmodome, the Planetarium or the Montreal Science Centre.

The finalist teams will receive the following prizes according to their position:

- 1st place: Helicopter tour over the city of Montreal, a scholarship worth $1000 awarded by Consortium for Research and Innovation in Aerospace in Quebec (CRIAQ) and virtual tickets to International Aerospace Week (September 6-8, 2022);
- 2nd place: ExoDrone study guide to become a drone pilot;
- 3rd place: AéroSim Experience in Laval.

Composition of the jury

The jury is composed of experts from the following organizations:

- Aéro Montréal
- CAMAQ, sector committee
- Consortium of Research and Innovation in aerospace in Quebec (CRIAQ)
- ÉNA / Quebec Aerospace Museum (MAQ)
- Stelia Aerospace
- Others, tbc

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Alain Thilloy – MTLS Aerostructure

Editorial team

Amina Chelabi, 3rd year student in aerospace engineering at Polytechnique Montreal
Anis Djama, 2nd year student in aerospace engineering at Polytechnique Montreal
Marc-Antoine Robillard, 3rd year student in aerospace engineering at Polytechnique Montreal

Bibliography

[1] ATAG. (2021). *Facts and figures.* [En ligne]. Disponible : https://www.atag.org/facts-figures.html