DESCRIPTION DU STAGE

Thématique(s) : Design & Optimization of Systems

Type de stage : ☑ Fin d’études bac+5 ☑ Master 2 ☐ Bac+2 à bac+4

Intitulé : Development of a tool to assess the concept of operation of a fleet of high speed civil transportation systems

Sujet : Since 2005, prospective studies dedicated to high speed civil transport (i.e. Mach>3), able to reduce of one order of magnitude the travel time along long haul routes, have been multiplied all over the world. Among the most famous projects, it is worth mentioning the European projects LAPCAT I & II [1] & [2] and the ongoing follow up project STRATOFLY [3], French project ZEHST [4], Japanese project HST [5], European/Japanese project HIKARI [6], together with some recent emerging concept planes from the American start-up Hermeus Corporation [7] and Boeing [8].

In view of the wide range of diversified vehicles and mission concepts, ONERA, and in particular, CEVA unity (Design & Assessment of Aerospace Vehicles) of DTIS department (Information Processing & Systems Department) has proposed to set up a MDAO (Multi-Disciplinary Analysis and Optimization) framework, specifically dealing with conceptual and preliminary design of high-speed transportation systems. Nevertheless, the initialization of the MDAO process requires a good understanding of the mission concept as well as the elicitation of the high level requirements to be fulfilled, such as the maximum cruise speed, the minimum achievable range, the type of propellant, the number of passengers, etc…. Ultimately, these high level requirements result from a preliminary investigation of the market demand and the hypothetical business case, to be traded off with the envisaged concept of operation.

The proposed internship aims at developing a stand-alone concept of operation tool (based on Python language) to support the MDAO design process. Its main outputs would be the travel time and cost per passenger per km for each potential routes and it would use the following inputs (non-exhaustive list):

- main characteristics and performance of the vehicle: cruise speed, cruise altitude, climb/descent gradient, lift to drag ratio, specific impulse of the engines, type of propellant, mass ratio, number of passengers, …

- routes, frequency of rotations along the routes, number of aircrafts in the fleet

- regulatory framework to be considered as reference to define the maximal acceleration, the sonic boom limitations, fuel reserve, emergency re-routing, minimal number of engines, … (NB: environmental constraints on emissions of greenhouse gas, NOx, noise will not be taken into account in a first step due to the non-maturity of the models of environmental impact and the lack of regulation for this type of vehicle)

The tool developed during the internship will consist of two different main modules:

- A Flight Mechanics module devoted to the prediction of the trajectory along the desired routes that will be based on the tool developed by ONERA within the research initiative “HypAirLiner”. The planned routes and the regulations to be applied will be based on the cases studied in the European/Japanese project HIKARI and the French project ZEHST. This module will be able to provide for each route the time travel and also the needed fuel mass which drives mainly the operational direct cost.
- A Life Cycle Cost estimation module (research & development cost, production cost, operational direct cost, operational indirect cost) that will be based on the methodologies developed by Politecnico di Torino [9] & [10] in ESA projects and currently used within the European H2020 STRATOFLY project. In particular, during the internship, special attention shall be devoted to understand the economic impact of the use of cryogenic fuels [11]. Results of past European funded project, such as LAPCAT I & II and the European/Japanese project HIKARI, can be used as benchmark for the validation of the module.

Beyond the application cases that will be considered during the internship (aircrafts ESA LAPCAT MR2, ONERA LAPCAT M8, Reaction Engines LAPCAT A2), this tool could also be used in the future as a baseline for the assessment of the concept of operations of a new civil aircraft concept (blended wing aircraft, electric aircraft, …) as well as to be used as a first step to assess the feasibility of new configurations of Reusable Access To Space Vehicles.

This internship will take place at ONERA Palaiseau in collaboration with Politecnico di Torino which will ensure partly the supervision of the trainee (especially concerning the elaboration of costs models).


Est-il possible d’envisager un travail en binôme ? Non

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<th>Méthodes à mettre en œuvre :</th>
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<tr>
<td>☐ Recherche théorique</td>
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<td>☒ Recherche appliquée</td>
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<td>☐ Recherche expérimentale</td>
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Possibilité de prolongation en thèse : Non
**Durée du stage** : Minimum : 4  
Maximum : 6  
Période souhaitée : Year 2020

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<th><strong>PROFIL DU STAGIAIRE</strong></th>
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<tr>
<td>Connaissances et niveau requis :</td>
<td>Ecoles ou établissements souhaités :</td>
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<tr>
<td>Master 2 in aerospace engineering</td>
<td>Politecnico di Torino</td>
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<td>Modular programmation (experience in Python language if possible)</td>
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