

Handling of Propulsion System in High-Fidelity Aero-Structural Aircraft Optimal Design

Proposal for Master Thesis
in Aerospace Engineering

Supervisor: André C. Marta, *IDMEC*

andre.marta@tecnico.ulisboa.pt

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Goals

This work addresses the challenge of incorporating the propulsion system in the design of fixed-wing aircraft using coupled aerostructural high-fidelity computational tools.

The motivation is driven by the desire of a Portuguese leading UAS manufacturer in developing a new Medium-Altitude, Medium-Endurance (MAME) UAV.

This work builds on previous wing and wing+fuselage aerostructural optimization, and should progress toward the inclusion of the propeller effects.

The goal is obtain a preliminary aircraft design, meant to be further studied and detailed, prior to a future prototyping.

Tasks

To meet the goal proposed, the work should be composed of the following main tasks:

- Bibliography Review
Revision of the state-of-the-art in the topics of computational fluid dynamics, computational structural mechanics, propulsion systems, multidisciplinary design optimization and sensitivity analysis methods;
Estimated time: 3 weeks.
- Problem Definition
Definition of representative scenarios for typical aircraft missions. Identification of the performance metrics, mission constraints and design variables;
Estimated time: 2 weeks.
- Aerostructural Analysis and Design
Familiarization with high-fidelity adjoint-based numerical tools for aerostructural design; setup of high-performance computing (HPC);
Estimated time: 3 weeks.
- Propulsion Model
Development of propulsion models for both propeller and jet engines, to estimate the wake and loads; numerical implementation of analysis models and corresponding analytical derivatives; demonstration on a simple engine on-wing design case;
Estimated time: 5 weeks.
- Integration in Design Framework
Integration of propulsion models in the numerical framework for aerostructural design optimization: assessment of coupled sensitivities; implementation and debugging on a trivial test case;
Estimated time: 5 weeks.
- Aerostructural Design
Optimal aircraft wing design under the influence of propulsion system: comparison

to isolated optimal wing, effect of multi-point operation (take-off, cruise, maneuver); optimal propulsion system installation;
Estimated time: 11 weeks.

- Thesis Write-up

Write-up of the dissertation thesis and corresponding oral presentation support material. The different technical topics covered should be described in detail, and a rigorous presentation is expected, both in visual and verbal terms, in a document logically structured.

Estimated time: 5 weeks.

Requirements

The proposed work requires knowledge covered in courses such as:

- Computational Mechanics
- Aerodynamics
- Computational Fluid Dynamics
- Aircraft Design
- Aircraft Optimal Design

The list mentioned is only illustrative of the scientific content of the work to be executed, it does not represent mandatory requirements. As such, the student that shows interest in this proposal is advised to previously discuss it with the supervisor.

Localization

IST (campus Alameda) and UAS manufacturer.

Observations

Possibility of scholarship to be discussed.

The student is strongly encouraged to start documenting his work since the first day. The recommended language for writing the dissertation is English.

Curriculum

- MEAer - branch of Aircraft

Calendar

The work to be developed has an estimated duration of six months, in accordance to the present curricular plan at IST. During that period, the student is expected to meet on a regular basis with the supervisor for follow up and discussion of ideas.

The student has full autonomy to manage his time in the way it suits him best, however a calendar is suggested according to the tasks described previously.

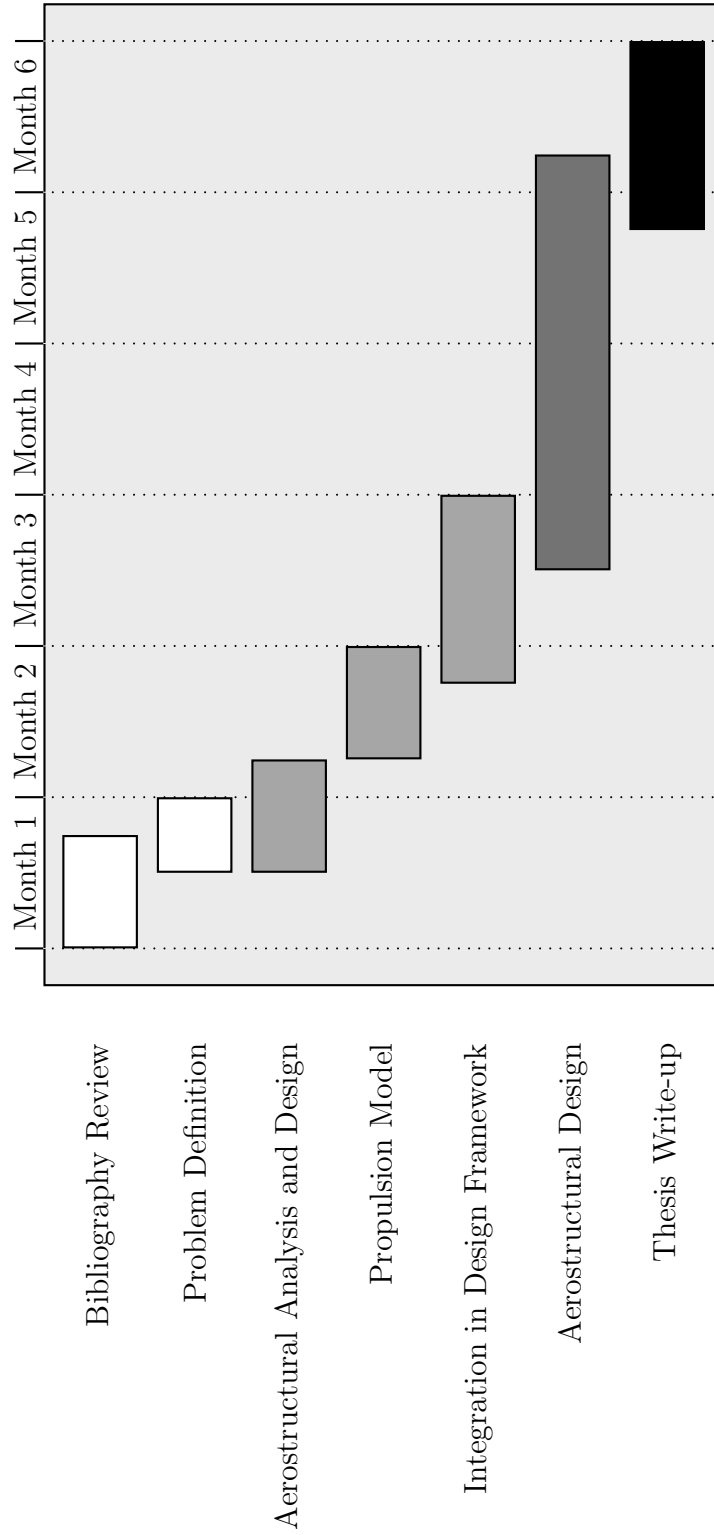


Table 1: Proposed Calendar