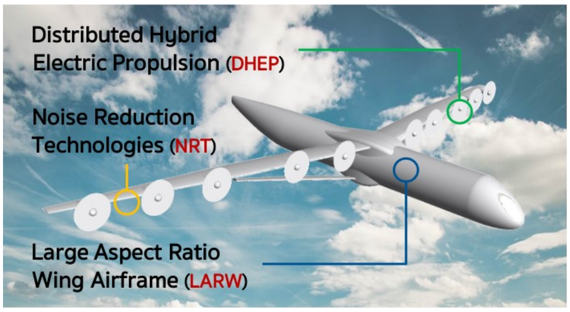
ASD Lab

uc3m | Universidad Carlos III de Madrid

INDIGO Horizon European research project recruiting

Project description

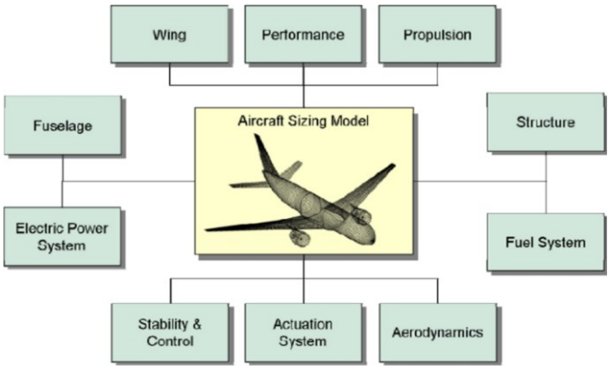


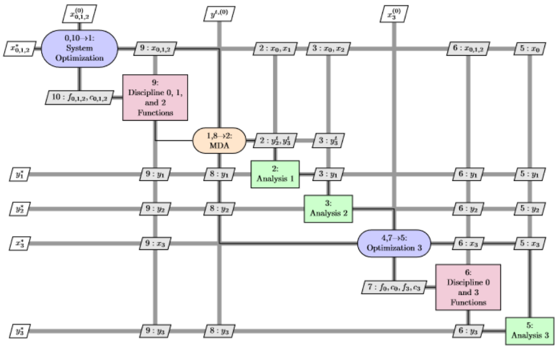
Achieving the goals of climate neutrality by reducing the impact of aviation is a task that requires a carefully drafted roadmap for the development of disruptive technologies and concepts of operations. With particular attention to the emissions of pollutants and noise in airport local airport areas, a synergetic approach is needed that combines interventions on the aircraft side and on the airport side. This calls for coordinated efforts in developing technologies that not only provide benefits during cruise conditions but also are capable of improving the local air quality and noise in airport areas where the impact of pollutants and annoyance to local communities has been demonstrated to be quite large in terms of morbidity and mortality. INDIGO is a collaborative project between academia, research centres and airports that aims at identifying the margins of improvement in airport local air quality and noise resulting from the introduction of a new non-conventional mid-range aircraft featuring distributed propulsion based on hybrid electric/sustainable and conventional fuel powertrain and large aspect-ratio wings capable to fly quietly and in zero-to-low-emission mode (i.e. electric and SAF) at low altitudes near airports and resort to conventional aviation fuel only when required, e.g. at higher altitudes or to recharge batteries during cruise. INDIGO will explore a new paradigm for the next-generation of silent and clean mid-range aircraft and for the way such a new aircraft will allow transforming the operations “at and near” airports. It will introduce improved methods for the analysis of future aviation environmental impact that, under the filter of uncertainty, will be able to account for non-conventional aircraft performance and future airport scenarios.

The Aeroelastic and Structural Design Lab (ASDLab) at University Carlos III of Madrid (UC3M) is offering **two** positions at PhD or Post-doc levels:

	PhD Studentship / Research fellowship(s)	
Topic	Multidisciplinary Design and Optimization (MDO) of Electric High Aspect-ratio wings Aircraft	Airframe design tools for multi-fidelity structural sizing and system integration of new generation quiet and green electric High Aspect-ratio wing aircraft
Reference	ASD0003-1	ASD0003-2
Closing Date	15/01/2023	
Department	Aerospace Engineering Department at University Carlos III of Madrid (UC3M)	
Research group	Aeroelastic and Structural Design lab (ASD Lab) https://aero.uc3m.es/asd_lab-home/	
Start Date (negotiable)	01/02/2023	
Eligibility	**Anyone eligible to work in Spain**. (See other requirements below)	
Duration of award	PhD: 3 years (extendable to 4 years) / Research fellow: 2 years	
Supervisors	Dr Rauno Cavallaro	Dr Andrea Cini

Position ASD0003-1: Multidisciplinary Design and Optimization (MDO) of Electric High Aspect-ratio wings Aircraft.





Description and objectives

The goal of this position is to perform a multidisciplinary optimization (MDO) of High-aspect-ratio wings (HARW) featuring Distributed Electric Propulsion (DEP) at different fidelity levels.
In the conceptual phase, the workflow will rely mainly on minimal-fidelity discipline modules provided by the same UC3M group and consortium partners. The multi-objective optimization will minimize environmental footprint indicators (aeroacoustics and pollutions in the airport neighbourhood) while maintaining competitive performances in the cruise phases.
In the preliminary phase, the workflow will rely on higher-fidelity discipline tool developed by consortium partners. The activity of the candidate will include:

- Using the State-of-Art approaches, tools and library in MDO (e.g., AGILE suite https://www.agile-project.eu/open-mdo-suite/, GEMSEO https://gemseo.readthedocs.io/en/stable/, OpenMDAO https://openmdao.org/)
- Integrating the several discipline modules within the optimization workflow.
- Selecting the most promising MDO mathematical formulations (MDO architectures)
- Launching the optimization campaign and support all related activities.
- Further advancing the SoA of MDO of new generation aircraft.

Entry Requirements

Applicants **must**:

- **Be eligible to work in Spain**
- For the PhD studentship: hold a MSc (or MSc student with 60 ECTS passed at contract signature) in aerospace engineering or a relevant discipline. Students with a background in MDO and aircraft design are particularly encouraged to apply
- For the Research Fellowship: hold a PhD and demonstrated experience in MDO and aircraft design
- Have an outstanding academic record, critical and creative thinking.
- Be proficient in English (oral and written).
- Deal independently and proactively with scientific and engineering challenges; be self-motivated and capable of working under pressure to meet deadlines.
- Have programming skills (e.g., Python).

Position ASD0003-2: Airframe design tools for multi-fidelity structural sizing and system integration of new generation quiet and green electric High Aspect-ratio wing aircraft

Description and objectives

This researcher position aims at developing multi-fidelity design procedure for performance optimisation of new generation green and quite aircraft featuring High-aspect-ratio wings (HARW) and Distributed Electric Propulsion (DEP). The activity will be mainly focus on developing the structural sizing tools defining the airframe internal structures and mass distribution. Flexible structural tools are required to quantitatively evaluate structural configurations in term of weight, manufacturability and cost. Different level of fidelity as well as several optimisation architecture strategies will be assessed and compared in term of accuracy and computational cost. Airframe sizing and weight estimation procedures will be adapted to assess weight penalties and internal structure modifications required for an efficient integration of the distributed hybrid/electric powertrain within a large aspect ratio wing airframe. Minimum weight structural optimisation methods will be developed fostering the implementation of advanced composite materials and multifunctional structures. Preliminary weight estimations will be computed by ROMs obtained from both modified advanced beam-based FEM and GFEM-based airframe sizing procedures. In conceptual phase, mass estimation will rely mainly on minimal-fidelity airframe sizing approaches. Low/mid fidelity models will be developed on the basis of modified beam theories to design aircraft wing components satisfying stiffness, strength, stability, flutter, durability and damage tolerance requirements. Minimum weight optimisation principles and manufacturing constraints will be included into the model identifying weight saving potential and feasibility of different structural solutions. Model versatility will be ensured allowing the analysis of both isostatic and hyperstatic wing architectures and composite wing boxes, consisting of different materials whether isotropic or orthotropic. Damage tolerance constraints will, be enforced optimising, therefore, composite staking sequences for impact and bucking resistance. Ply-drop strategy will be considered for weight saving by constraining adjacent beam cross-sections. Owing to the large deflection of the structure, the analyses will be geometrically nonlinear estimating also shear deformations and composite interlaminar stress by simple approximation methods (Layer-wise theory). Specific attention will be paid to simulate non-structural masses and loads deriving from the fuel tanks, hybrid/electric powertrain and distributed propulsion integration. The aerostructural coupling effect will require the evaluation of design response sensitivities to aerodynamic or architecture shape parameters as well.

GFEM models will be developed on the basis of the preliminary beam results to improve the material distributions prediction by using shell elements. Mid/high fidelity GFEM will enhance the procedure accuracy by including design details such as assembly techniques and component joints. Size and free size optimisations will be applied to optimise material distribution and composite ply shape for minimum weight aeroelastic tailoring. Staking sequences internal optimisation will be coupled with size procedure to enable the automatic generation of composite laminates to maximise weight saving while fulfilling ply book rules and manufacturing constraints. Ply drops and thickness variation strategies will be assessed to seek a suitable trade-off between weight saving and manufacturability. Damage tolerance and failure constraints will be enforced by means of design of experiments based on dedicated virtual testing models. Process based cost models will provide accurate estimation on the manufacturing recurring and nonrecurring costs. Ad hoc lightweight solutions will be investigate to house the novel powertrain and auxiliary systems ensuring redundancy and inspection and maintenance accessibility. Certification, manufacturing, assembly and operational constraints will be considered at different level of fidelity to select and size feasible airframe structural solutions resulting in reliable weight predictions. Surrogate models based on the optimisation procedure results will be created to obtain a simple preliminary structural design tool to optimised green and silent aircraft architectures. The research activity will include:

- Developing shell-accurate beam element for multi-material hybrid tapered sections
- Defining modelling strategy to include system integration into GFEM
- Developing stress analysis and mass estimation DoE and surrogate models
- Performing minimum weight optimisation
- Developing advanced composite material optimisation
- Developing a strategy to effectively include certification and manufacturing constraints in airframe optimisation routines
- Using in-house FE codes (Augusto) and commercial software (Nastran, Abaqus, OptiStruct)

Entry Requirements

Applicants **should**:

- **Be eligible to work in Spain**
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- Hold a MSc (or MSc student with 60 ECTS passed at contract signature) in aerospace engineering or a relevant discipline (such as applied mathematics).
- Students with a background in aircraft design, aerostructures and FE analysis are particularly encouraged to apply
- Have an outstanding academic record, critical and creative thinking.
- Be proficient in English (oral and written).
- Deal independently and proactively with scientific and engineering challenges; be self-motivated and capable of working under pressure to meet deadlines.
- FE, programming (Pyton) and coding skills will be an added value

Positions offers and benefits:

The successful applicants will:

- Work as part of the INDIGO Horizon Europe research project
- Become part of a young, dynamic, highly qualified, collaborative team.
- Experience flexible working environment and schedule.
- Have opportunities to travel to international conferences to present research activities.
- Have opportunity to carry out research internships abroad.
- Be involved in other research activities within ASD Lab
- Have health coverage under the National Health System.
- PhD studentship: receive an average bursary between 18.000€ – 24.000€ p.a. based on experience and performance and tuition fees for three/four years
- For Post-doc fellowship: a stipend of 25000€ – 35000€ p.a. based on experience and performance for two years
- Have salary raises and production prices based on performance

For further information please contact:

- **Position ASD0003-1: Dr Rauno Cavallaro** (ASD Lab), T: **+34 91624 8232**, E: **rauno.cavallaro+asd0003-1@uc3m.es**

- **Position ASD0003-2: Dr Andrea Cini** (ASD Lab), T: **+34 91624 8238**, E: **andrea.cini@uc3m.es**

Applicants are recommended to contact Dr Rauno Cavallaro or Dr Andrea Cini to start the official application.