MADELEINE

2nd European Workshop on MDO

19-20 November 2019

Toulouse, France

Coordinator:
Michaël Méheut (ONERA)

MADELEINE project,
Grant Agreement No 769025

Consortium MADELEINE

MADELEINE	**Multidisciplinary ADjoint-based Enablers for LargE-scale Industrial desigN in aEronautics**
Call H2020-Transport 2017-MG 1.3	Industrial competitiveness
Coordinator	ONERA THE FRENCH AEROSPACE LAB
15 partners	AIRBUS, Rolls-Royce, DASSAULT AVIATION, esi, OPTIMAD ENGINEERING, DLR, nlr, IRT SAINT EXUPERY, Università di Cagliari, UNIVERSITY OF Southampton, The University Of Sheffield, TECHNISCHE UNIVERSITÄT MÜNCHEN, National Technical University of Athens, UP
Duration	36 months (June 2018 – May 2021)
EU funding	5.8 M€

Current use of MDO in industry

MDO and/or **adjoint-based optimisation** using **high-fidelity** simulations	Often **limited** to **single disciplines**: ✓ *Aerodynamics* ✓ *Acoustics* ✓ *Thermics* ✓ *Structural analysis*
Multi-Disciplinary analysis during **design** campaign	**Iterative process** from **one discipline** to the other

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Limitations and **drawbacks** of the current approach	Significant **time delays** to the overall process Difficulties to exploit **multi-disciplinary trade-off**

Overall objectives of MADELEINE

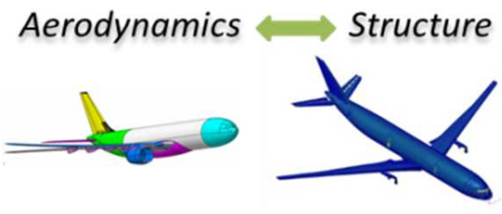
Meet short, medium and long-terms industrial objectives	✓ **Competitiveness** - By *reducing development time* and *costs* (incl. *manufacturing*) ✓ **Environment** - By *designing more efficient configurations* with better *multidisciplinary compromises*
Address the industrial needs of competitive design	✓ Extend the scope of **MDO** to include ***HiFi* simulations** (*CFD, CSM, CAA, CHT)* ✓ Fully **exploit** the **adjoint capability** to solve design problems with **hundreds or thousands** of design parameters ✓ Increase the **reliability** of the **adjoint** solvers ✓ Extend MDO to efficiently include **manufacturing criteria**

Overall objectives of MADELEINE

Demonstrate the **benefits of adjoint-based MDO**

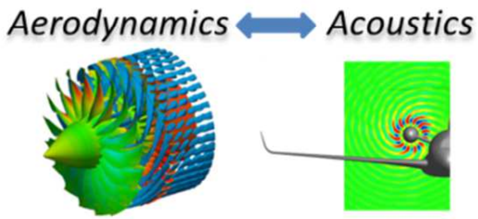
Airframe

Wing/fuselage aero-structure interactions



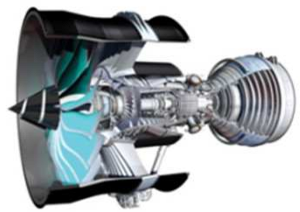
Airframe/engine interactions

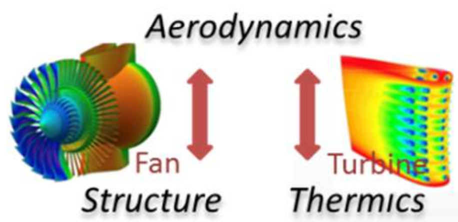
Air inlet, propeller or fan blades aero-acoustics interactions



Engine

Fan and high-pressure turbine with very stringent aero-structure and aero-thermal interactions



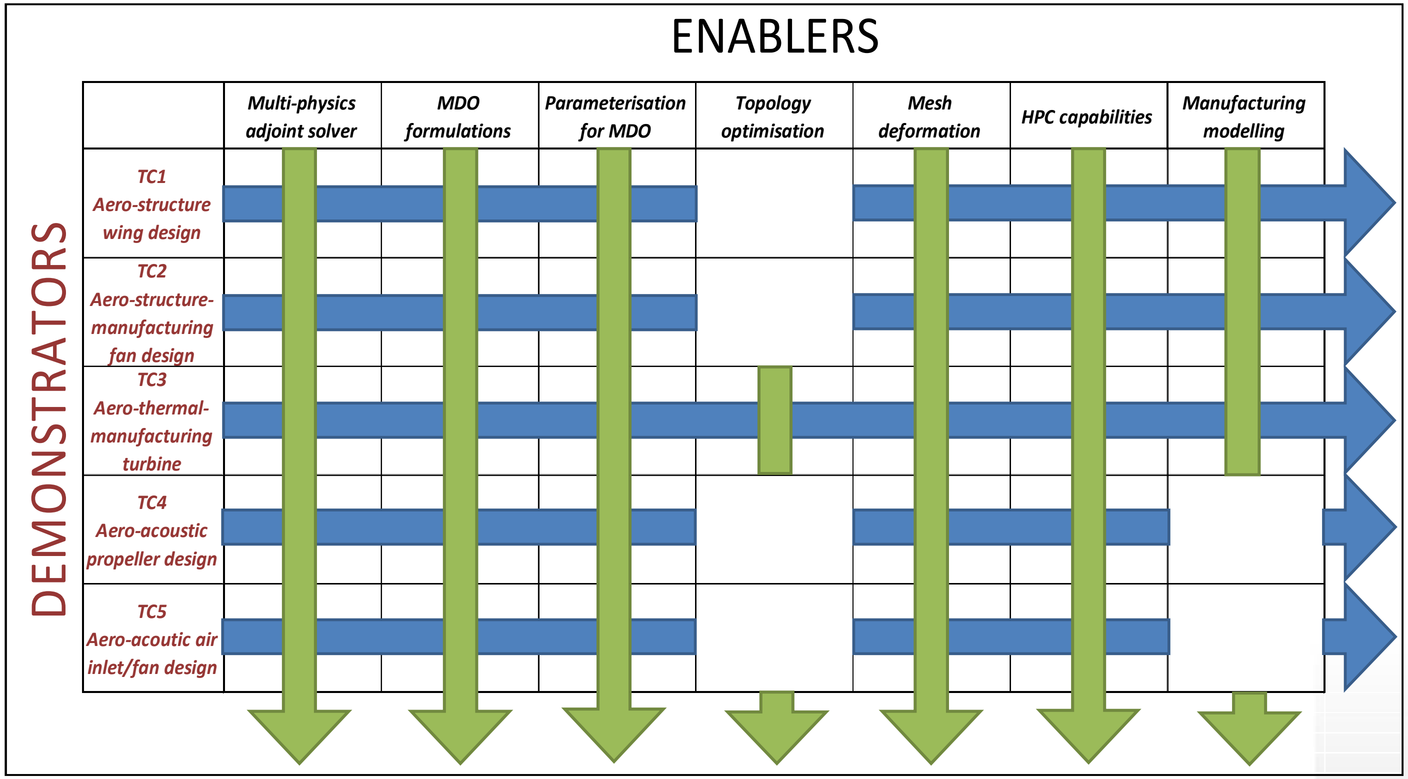


Concept of MADELEINE

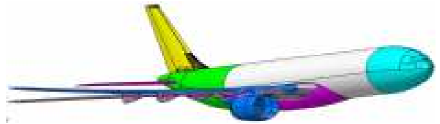
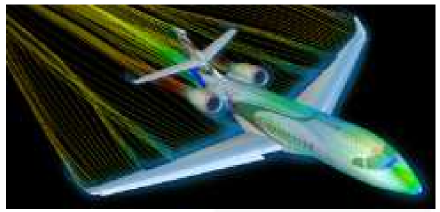
Focus on synergies between enablers and demonstrators

Enablers: methods and tools required to apply adjoint based MDO processes

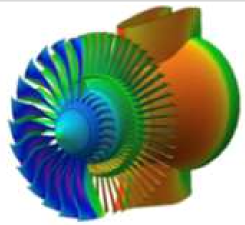
Demonstrators: test cases representative of multi-physics industrial design problems



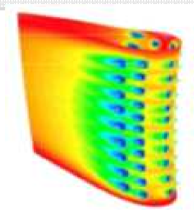
Aero-structure aircraft wing design

Challenge	Perform **aero-structure flexible wing optimisations** of modern transport aircraft in a **real industrial context**
Strategy	Apply of ***aerodynamic, aero-elastic and aero-structure adjoint solvers*** to measure the impact of multiphysics phenomena on the performance of optimised configurations
Configurations	A **large passenger aircraft** configuration (Airbus) *Partners: Airbus, ONERA, DLR, IRT*  A **business jet** configuration (Dassault) *Partners: Dassault, ESI, National Technical University of Athens* 

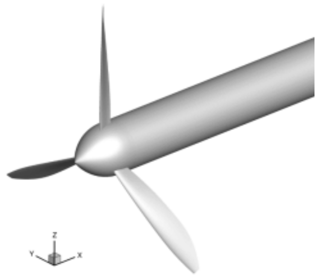
Aero-structure-manufacturing fan blade design

Challenge	Perform **aero-structure-manufacturing fan blade optimisations** of a Ultra-High-By-pass-Ratio modern engine
Strategy	Progressively include **manufacturing aspects** on the MDO process to avoid **accumulation of deviations** that can cause the blades to **deviate from the design intent** in terms of optimal **efficiency**
Configurations	3 levels of complexity from **generic configuration** (NASA rotor 37) to **complex industrial geometry** (confidential Rolls-Royce)  All configurations are **representative** of **modern aircraft engine** (Low-Pressure Fan) *Partners: Rolls-Royce, University of Sheffield, University of Cagliary*

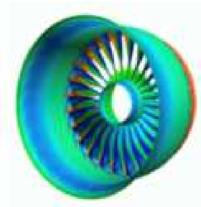
Aero-thermal-manufacturing turbine blade design

Challenge	Perform **aero-thermal-manufacturing turbine blade optimisations** of a Ultra-High-By-pass-Ratio modern engine
Strategy	Use **topology optimisation** methods for the definition **cooling passages** Integrate of **specific manufacturing process** or **uncertainties** in the MDO loop to design configuration **robust** to **geometry deviations**
Configurations	3 levels of complexity from **generic configuration** (MT1) to **complex industrial geometry** (confidential Rolls-Royce)  All configurations are **representative** of **modern aircraft engine** (High-Pressure Turbine) *Partners: Rolls-Royce, University of Sheffield, University of Cagliary, ESI, OPTIMAD, National Technical University of Athens*

Aero-acoustic isolated propeller blade design

Challenge	Perform **aero-acoustic propeller blade optimisations** of modern turbo-propulsor engine
Strategy	Use **vertex morphing approach to open the design space** Apply **steady** and **unsteady aero-acoustic adjoint solvers** to minimise the **acoustic noise** while considering strong **aerodynamic constraints** (in terms of performance)
Configuration	Generic design complying with the requirements of **an electrical or hybrid CTOL/VTOL concept** using light propellers (ONERA)  *Partners: ONERA, NLR, Technical University of Munich*

Aero-acoustic air inlet and fan blade design

Challenge	Perform simultaneously **aero-acoustic air inlet** and **fan blade optimisations** of a Ultra-High-By-pass-Ratio modern engine
Strategy	Optimise the air inlet (including **acoustic liners**) and the fan blade in parallel with **a specific coupling interface** Apply **steady** and **unsteady aero-acoustic adjoint** solvers to improve **both aerodynamic** and **acoustic performance**
Configuration	**Generic air intake** adapted to the **VITAL fan blade** geometry  *Partners: Rolls-Royce, University of Southampton, National Technical University of Athens*

Meet with us

Next Minisymposium *at the* ***14th World Congress in Computational Mechanics and ECCOMAS Congress 2020***
Paris, 19-24 July 2020

ADJOINT METHODS FOR MULTI-PHYSICS, INCLUDING APPLICATIONS

Deadline for abstracts: December 15, 2019

And stay tuned!

Website: https://www.madeleine-project.eu/

www.linkedin.com/company/madeleine-project

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