MADELEINE STANDS FOR "MULTIDISCIPLINARY ADJOINT-BASED ENABLERS FOR LARGE-SCALE INDUSTRIAL DESIGN IN AERONAUTICS".

The project focuses on the development and validation of multidisciplinary design tools for optimisation.

Special attention is given to:

- multidisciplinary optimisation
- understanding of multi-physics phenomena
- simulation of manufacturing processes
- transition to High-Performance Computing

Our media releases include interviews with project partners to let you discover how they cooperate to achieve the project objectives. The "Get Together" section will show you when we disseminate the MADELEINE results. This is in case you feel like meeting with us! Meanwhile, we invite you to visit our website at www.madeleine-project.eu and follow us on Linkedin via #madeleineproject

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769025.

INTERVIEW WITH ITHAM SALAH EL DIN, ONERA

DR. ITHAM SALAH EL DIN: RESEARCH ENGINEER IN AERONAUTICS

Question 1 (Q1): ONERA is the leader of the work package entitled "Propeller and integrated fan design" in MADELEINE. Can you describe the structure and objectives of this work package?

Answer 1 (A1): The ambition of this work package is meant to demonstrate the added value of taking into account simultaneously aerodynamic and acoustic in the design optimization process coupling MDO (Multi-Disciplinary Optimization) algorithms with high fidelity CFD and adjoint solvers developed in the "Methods and tools" work packages of the MADELEINE project. It represents a real challenge as little know-how exists on this subject and aeroacoustic adjoint. Moreover, propeller and turbofan noise optimisation have not been addressed with such high fidelity so far in Europe and scarcely in the worldwide community, although they are cases of great practical interest for engine and aircraft manufacturers. MDO on such configurations is very challenging as reducing the engine noise while improving aerodynamic and structural performance prove to be generally antagonistic. To push toward a rise in our knowledge as well as our technology readiness level, two relevant use cases have been defined: an isolated academic propeller HAD-1 provided by ONERA complying with the requirements of an electrical or hybrid CTOL/VTOL (Conventional/Vertical Take-Off and Landing) concept using light propellers and the VITAL engine, a modern high bypass ratio jet engine designed by Rolls-Royce.

Q2: What were the main steps in optimising the use cases?

A2: Without geometry, there is nothing to optimize, so the first step was to define and deliver a CAD-ready geometry to all partners. For both use cases an automated optimization workflow was set up, able to tackle either mono or multi-disciplinary problems, coupling the advanced shape deformation of these geometries, the performance and its adjoint based sensitivity with respect to a prescribed shape parameterization with an optimization algorithm. Then a thorough validation study has been led for all

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cases and, as little know-how existed even for pure acoustic or aerodynamic adjoint gradient based optimizations for engine or propeller, optimizations were achieved to understand how the shape and the physics would interact to improve each discipline separately. Finally, both disciplines were taken into account to find the best compromise and help understand how they are meant to interact.

Q3: What are the main achievements today?

A3: The choice of two different use cases was made to tackle two fundamentally different but still ambitious physics to optimize. As a matter of fact, the nature of the interactions between the aerodynamics and the acoustics are very specific for each case, justifying all the more their choices.

The propeller was meant to address aeroacoustics of blades without any fairing. The Technical University of Munich was able to test their advanced deformation tool based vertex lattice parameterization on the geometry, which will enable to take full advantage of the adjoint approach in future works. From the optimization point of view, the particularly challenging item in this use case was to take into account unsteady flight conditions, which was done by NLR, first time to be seen in Europe. The steady multi-disciplinary optimizations were performed successfully, taking into account aerodynamic objectives and as well as the acoustic ones, with the demonstration of improving the aero acoustic performance even for off design conditions.

Regarding the VITAL engine, both the fan itself and the inlet were undergoing aero-acoustic optimization, also taking into account structural constraint. What is remarkable is the fact that it implies that multiple research partners (National Technical University of Athens, University of Southampton, University of Sheffield) had to work together and giving the best of their own optimization capabilities in terms of methods and tools, with the guidance of the industrial needs provided by Rolls-Royce. The partners converged towards a technical solution, defining a common perturbation interface so that the inlet and the fan could be optimized simultaneously. Both components have been optimized for aero acoustics providing promising results and using dedicated metrics and the exchange process meant to take into account the impact of the respective modifications settled. The high ambition of the National Technical University of Athens to be able to take into account liners for acoustic damping have also helped to go farther in the knowledge and the development of a linearized parametric capability and will definitely prove valuable in future projects involving engine acoustic levels reduction.

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GET TOGETHER

Get Together selects the events at which MADELEINE will be represented until the end of the year.

CM3-TRANSPORT 2021, 22-24 NOVEMBER 2021, BARCELONA, SPAIN

The thematic workshop of ECCOMAS "Computational Multi Physics, Multi Scales and Multi Big Data - CM3. Methods, Tools and Technologies for Design in Aviation" will be held in November. The workshop is planned as a physical event hosted by CIMNE in Barcelona. In view of the situation of the Corona-pandemic, the organisers will decide in due time, whether the event can take place physically as planned, or has to be transformed to a virtual event (on-line) or to a hybrid workshop (restricted on-site participation and on-line). The decision will be announced on this workshop website. **The MADELEINE project will be represented with 5 presentations by Dassault Aviation, DLR, National Technical University of Athens, ONERA and University of Cagliari.**
More information: CM3

MADELEINE FINAL PUBLIC EVENT, 25-26 NOVEMBER 2021, VIRTUAL

The MADELEINE project is happy to announce the organisation of its Final Public Event which will take place **virtually in the afternoon of Thursday 25th and in the morning of Friday 26th of November 2021.**
The aim of the Final Public Event is to showcase the final results of the project in terms of Adjoint Based High Fidelity Multidisciplinary Optimisation.
The MADELEINE partners will give **more than 10 presentations** on the development and related achievements of the key project methods, tools and test cases followed by a discussion session.
The detailed agenda is available on our website.
The Final Public Event will be virtual, open and without registration fees. However, registration is mandatory.
To sign up, please send the following text: "I wish to register to the MADELEINE Final Public Event on 25-26 of November 2021" to dominika.behrendt@l-up.com
More information: MADELEINE website

We hope to meet you soon!

CONTACT US

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MADELEINE in a nutshell:

GRANT AGREEMENT NUMBER: 769025	**15** PARTNERS	**6** EUROPEAN COUNTRIES	CALL: **H2020-MG-2016-2017**
50 RESEARCHERS AND ENGINEERS	**RESEARCH & INNOVATION** ACTION	TOTAL MANPOWER: **631** PERSON-MONTHS	TOTAL BUDGET: **5 815 181 EUROS**
36 MONTHS	**TOPIC:** MG-1.3-2017	PROJECT COORDINATOR: **MICHAËL MEHEUT** (ONERA)	PROJECT OFFICER: **MIGUEL-ANGEL MARTI-VIDAL** (INEA)

MADELEINE consortium:

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