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 THE TEAM OF OPTIMAD ENGINEERING, TURIN, ITALY

MARCO CISTERNINO, SENIOR SOFTWARE DEVELOPER

HAYSAM TELIB, CEO

Question 1 (Q1): Optimad is the leader of the work package entitled "Efficient MDO process" in MADELEINE. Can you briefly describe the structure and objectives of this work package?

Answer 1 (A1): Multidisciplinary optimisation (MDO) is both a complex and costly process. In the wok package "Efficient MDO process" we focus on the latter aspect.

Actually, since MADELEINE is targeting industrial needs, we distinguish between operational cost, i.e. the cost of running the MDO process, and capital costs, i.e. the one-time effort needed to put the MDO process in place. We use this nomenclature in order to facilitate the communication between the engineering department and the managerial structure.

In MADELEINE, we envisage the reduction of both. In order to reduce the operational costs, we exploit modern High-Performance Computing (HPC) architectures and algorithms that suit well these machines.

In order to reduce capital expenses, we use modern programming paradigms, in order to facilitate the exchange among different disciplines and their orchestration.

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Q2: What were the main steps in developing an efficient MDO process?

A2: To answer this question, we have to make a step back in order to understand the current situation and the challenges of the future.

The MDO process is made of several bricks that individually have been developed over the last decades by engineers. These engineers were also responsible for the performance optimisation of these bricks, that could be easily achieved since the target computer architecture remained unchanged for a long time. However, over the last ten years, computer architectures evolved incredibly and it is difficult to forecast what will be the mainstream products even in five years from now. It is certain that new computers will be more complex than the ones that engineers are used to, made of different types of computing units on the same motherboard. Consequently, it is very difficult to optimise the performance of software for such complex architectures. And furthermore, engineers and managers fear that a hypothetical big investment in optimisation may be made obsolete by the rise of a new architecture in the near future.

What we are doing in MADEINE is a first step towards a resilient approach to this scenario:

We decompose a big piece of software in three layers:

1. The interfaces: this layer is responsible to exchange efficiently (big) data with other software and the MDO orchestrator. Dedicated protocols are developed by IT experts within MADELEINE that can be used such as the http protocol, but for big and distributed data.

2. The numerical algorithm: this is the translation of the mathematical problem in a numerical scheme. Within MADELEINE, we extract this layer from existing codes.

3. The computational core: this layer is responsible for the efficient mapping of the numerical algorithm to the available HPC infrastructure and solving the system of equations. We use dedicated libraries developed such as PETSc and TRILINOS to achieve this mapping.

With this decomposition, we can use best in class software (either developed by the MADELEINE consortium or externally) to overcome each inefficiency in the MDO process.

Q3: What are the main achievements today?

A3: Regarding the standardisation of the interfaces, we have showed a huge gain of transfer time with respect of the standard solution used today and an increased fault tolerance.

Also, the solving phase has showed considerable speed-up for two of the most important bricks in the MDO process: 5x speed-up of solution of the adjoint equations and 10x speed-up for the mesh-morphing.

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Q4: What were the main challenges that the project partners met while developing an efficient MDO process?

A4: The simulation software used in MADELEINE has been developed over many years and by many people, absorbing huge investments. It is used by different stakeholders, mainly by the industry. And the software is continuously improved. It is difficult to introduce a discontinuity in the way of proceeding, especially at this level of maturity. It takes risk mitigation strategies, that increase further the cost of this transition.

Also the uncertain future, in terms of computer architecture and technology, takes the challenge to a different level. In fact, we are not refactoring a code for a new architecture, we are introducing new paradigms to accommodate this uncertainty and to be prepared to ANY architecture that will come in the next future.

The partners of the MADELEINE project had to step out of their comfort zone and question a lot of things.

Q5: In MADELEINE, the technology developments called enablers are driven by industrial needs represented by the project demonstrators. The consistency between the developments and industrial needs is guaranteed by the requirement that each enabler is tested on at least one demonstrator. How is the MDO process used in the demonstration activities of the project? How are the improvements verified and quantified?

A5: The effort needed to demonstrate the gains in efficiency on the industrial test cases goes beyond the investments of the MADELEINE project.

In fact, the gains are demonstrated on some isolated bricks and on some ad-hoc toy problems that permit a realistic estimate of the expected gains in the real-world scenario.

It will be up to the single partners or some follow-up initiative to implement these solution in the entire solution stack.

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GET TOGETHER

Get Together selects the events at which MADELEINE will be represented in 2020 and 2021.

AERODAYS 2020, 24-26 NOVEMBER 2020, VIRTUAL

MADELEINE video will be showcased at the virtual exhibition booth of the European Commission.
Source: Aerodays 2020

WCCM-ECCOMAS CONGRESS 2020, 11-15 JANUARY 2021, VIRTUAL

The MADELEINE partners are organising the **mini-symposium** "Adjoint Methods For Multi-Physics, Including Applications" in the framework of the 14th WCCM-ECCOMAS Congress. Those who already have an accepted paper will be able to propose a recording of their talk via a platform provided and to participate in virtual moments of exchange.
Source: WCCM-ECCOMAS Congress 2020

EUROGEN 2021, 17-19 MAY 2021, ATHENS, GREECE

14th International Conference on Evolutionary and Deterministic Methods for Design, Optimization and Control is an ECCOMAS thematic conference. The MADELEINE partners are organising a **symposium** dedicated to the project. **Abstracts can be submitted until 30 November 2020!**
Source: EUROGEN 2021

AIAA AVIATION 2021, 7-11 JUNE 2021, WASHINGTON, USA

The annual AIAA Aviation and Aeronautics Forum and Exposition draws participants from around the globe. The MADELEINE partners are organising a **special session** dedicated to the project. **Abstracts can be submitted until 10 November 2020!**
Source: AIAA Aviation Forum 2021

We hope to meet you soon!

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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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