domminio

Digital method for improved manufacturing of next-generation multifunctional airframe parts

Newsletter

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aimen
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“Dear Reader,

I am glad to share with you the Issue #2 of the DOMMINIO Newsletter. The DOMMINIO project (Digital method for imprOved Manufacturing of next-generation MultIfuNctIOnal airframe parts) commenced on the 1st of January 2021 and aims at developing an innovative data-driven methodology to design, manufacture, maintain and pre-certify multifunctional and intelligent airframe parts, for cost-effective, efficient, and sustainable manufacturing.

The methodology of DOMMINIO is based on:

- ✓ Robotized technologies (ATL, FFF)
- ✓ Advanced simulation tools
- ✓ On-line process & quality monitoring
- ✓ SHM (Structural Health monitoring) methods enabled by real time data-driven fault detection

Entering the last year of the project's full operations, several goals have been reached highlighting DOMMINIO's progress.

Enjoy the read & stay connected with DOMMINIO via our communication channels! ”

lets connect!

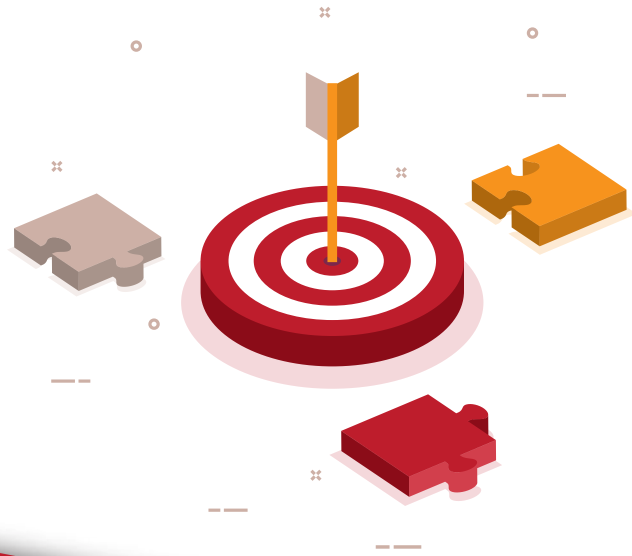
WP2 Process numerical modeling and multifunctional prototypes design

WP2 aims to develop numerical models of ATL and FFF processes for designing the optimum strategy for manufacturing the multifunctional composite representative prototypes in WP6 - Laboratory integration and data pipeline realization. **Experimental and advanced simulation techniques** have been used to link the manufacturing process parameters and the performance of the final prototypes, including the definition of a methodology to establish the optimal design. The specific objectives of the WP2 aim at:

1. Developing a numerical model of the consolidation process during the composite lay-up process to predict the level of intimate contact at the plies interface and able to propose the set of parameters to be used as a reference.

2. Developing a computer simulation model of the deposition of TP composite filaments reinforced with continuous fibre by FFF, predicting the bonding behavior in the interlayer and able to propose a set of parameters to be used as a reference.

3. Developing the mechanical design of composite laminates using FEM. The simulation will include the interface characteristics at the plies within the composite laminate and will define the optimal plies configuration, number of plies, and their orientation with respect to the orientation of the functional fibers.



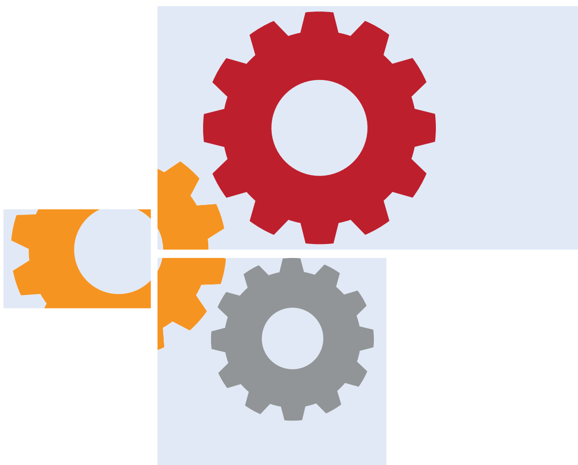
WP2 ATL process

ATL was addressed by considering two main aspects: the analysis of the incoming tapes (in particular their surface roughness) and the parametric simulation of the thermal process, enabling the sensitivity analysis and the real-time control.

Composite surface description was carried out by using advanced topological data analysis, able to describe the roughness from a multi-scale viewpoint, as well as enabling an invariant characterization that allows comparing surfaces and controlling the process for adapting the process parameters to the incoming tape surfaces (the consolidation occurs at the interface where the right temperature, during the right time interval is needed, as well as a perfect intimate contact).

Parametric process simulation was performed by constructing a response surface, by employing the non-intrusive Proper Generalized Decomposition, while addressing the very different characteristic dimension of the tape (very small thickness). This parametric solution enables determining very e ciently the process window as well as the online process-control.

Developed a quick response distortion model that was used for a unit gyroid cell and for large gyroid structures. Validation is to be pursued with lab scale deposits.



WP2 FFF Process

The complexities of FFF process are subdivided into several models: The nozzle, the deposition and distortion. The deposition model is a micro model where the interaction between the resin and the nozzle and the substrate is resolved to determine the lament shape. It relies on nozzle details obtained from the model analyzing the nozzle thermal and ow details and delivers the required information to drive the distortion model. All three models have been successfully demonstrated and validated.

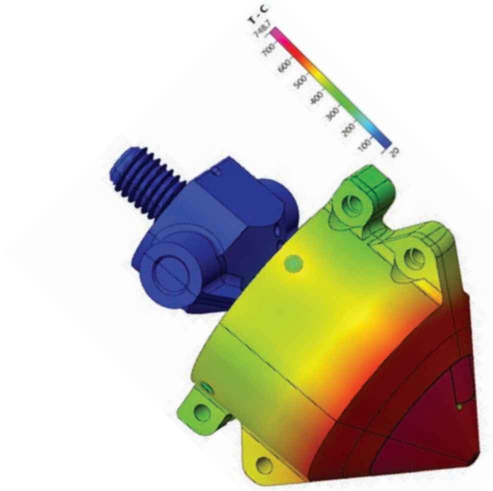


Figure 1: Temperature distribution on outer skin of 45o nozzle

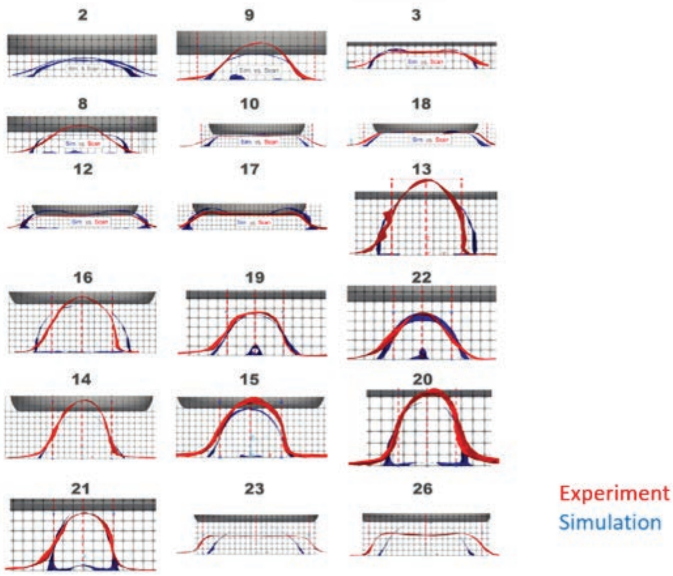


Figure 2: Comparison of numerical predictions with scanned filament cross sections.

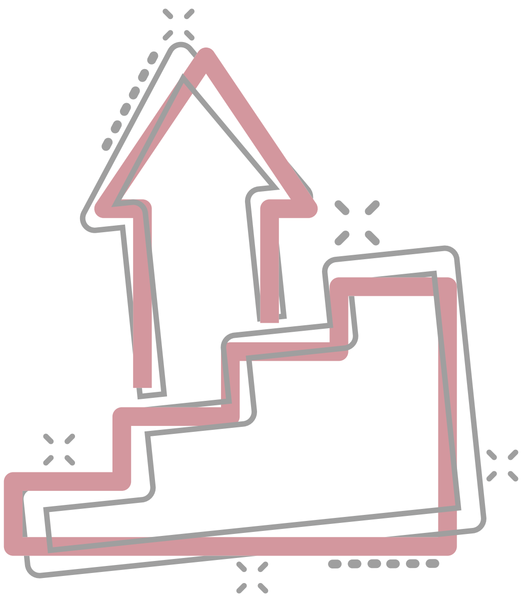
WP2 Contribution to the DOMMINIO project

The models are verified and validated in the early stages of development against relatively simple experiments (e.g. single filaments). They are then applied to study larger deposits to guide demonstrator design and to assess manufacturing constraints and outcomes. The continuous exchange between modelling and experimental teams allows for continued improvement of the models and refinement of the experiments towards a successful demonstration of the developed materials and technologies.

WP2 Next Steps

The next steps in this work package include:

- Validation of the developed ATL methodologies and tools within AIMEN facilities.
- Validation of the distortion model and the methodology developed.
- Application of the FFF models within the MDO framework.



Events

DOMMINIO team will participate in the following events:

- **3rd training: Smart Sensing Applications/ Zurich, CH/ June 2023**

- **11th International Conference on Composite Testing and Model Identification/ Girona, Spain/ May 31 – June 2, 2023**

- **XV National Congress of Composite Materials / Gijón, Spain / 13-15 June 2023**

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Our Team

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