domminio
Digital method for improved manufacturing of next-generation multifunctional airframe parts
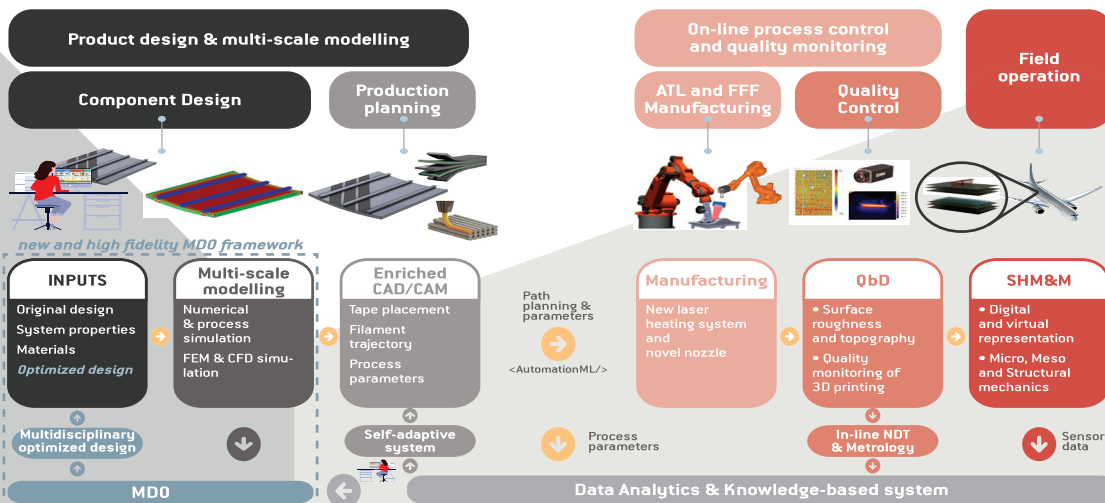
Digital method for impr0ved Manufacturing of next-generation MultIfuNctI0nal airframe parts

## Manufacturing systems specifications & conceptual design framework

Product design & multi-scale modelling

- Component Design
- Production planning

new and high fidelity MDO framework

On-line process control and quality monitoring

- ATL and FFF Manufacturing
- Quality Control

Field operation

INPUTS	Multi-scale modelling	Enriched CAD/CAM
Original design	Numerical & process simulation	Tape placement
System properties		Filament trajectory
Materials	FEM & CFD simulation	Process parameters
Optimized design		

Multidisciplinary optimized design

DOMMINIO Multi-objective-optimization framework

MDO

Path planning & parameters

<AutomationML/>

Self-adaptive system

Process parameters

Manufacturing
- New laser heating system and novel nozzle

QbD
- Surface roughness and topography
- Quality monitoring of 3D printing

SHM&M
- Digital and virtual representation
- Micro, Meso and Structural mechanics

In-line NDT & Metrology

Sensor data

Data Analytics & Knowledge-based system

AFP & FFF Process numerical modelling & multifunctional prototypes design

Creation of numerical models enabling simulating both AFP and FFF processes by combining advances simulation tools based on the use of:

▸ Model order reduction
▸ Advanced machine learning techniques

Parametric simulator

*Simulation of the filament deposition*

Surface measurement
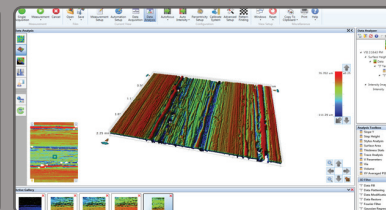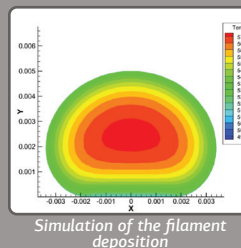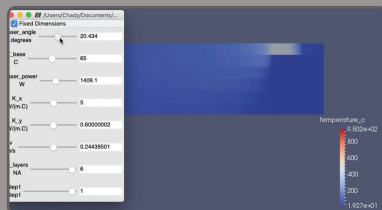
Sensor development & SHM of multifunctional composite laminates

Activities to enable the detailed mechanical failure analysis and detecting/locating damages in structural composites.
Multiscale modelling techniques are first used for developing a digital twin of the mechanical behavior of laminates.
Deep learning models, namely:

Defect Size & Position

defect

CNT Yarn sensors

ε_1 .... ε_n

Deep Learning Model
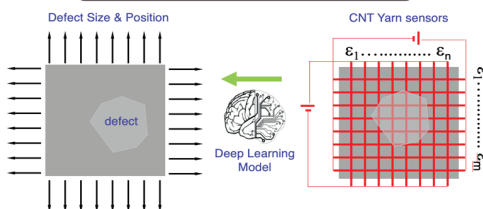
▸ Recurrent Neural Networks are used to generate surrogates of the mechanical behavior in a multiscale analysis.
▸ Convolutional Neural Networks are used to detect the presence of damages with information gathered with advanced CNT sensors integrated in the structural laminate.

Deep Learning model based on convolutional neural networks to detect damages in a structural laminate

## Functional materials engineering and manufacturing systems

Materials development & characterization

Thermoplastic composite filaments for FFF :
▸ Reinforced with **continuous carbon fiber (cCF)** for structural purposes,
▸ Reinforced with **continuous carbon nanotube fiber (cCNT)** for SHM
▸ Filled with **magnetic nanoparticles (MNP´s)** for debonding on demand.

Nanocomposite filament development set-up

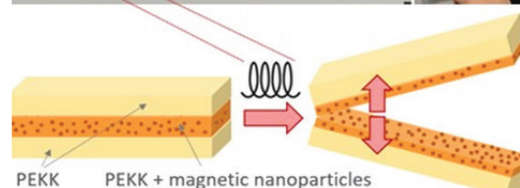**AFP Processing window**

AFP arm and heated table
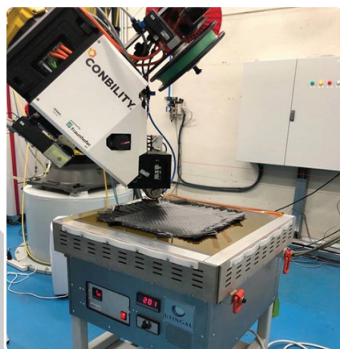
The AFP cell has been equipped with "heated table" for enhanced temperature control.

FFF Processing window

A laser heating system has been mounted in the FFF cell.

DOMMINIO FFF cell with the laser assisted heating system
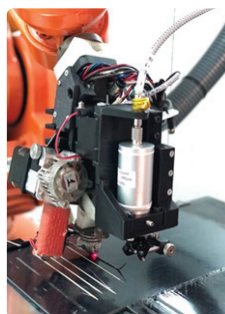
Disassembly Processing window

PEKK   PEKK + magnetic nanoparticles

DOMMINIO FFF cell with the laser assisted heating system

The induction heating apparatus for testing developed nanocomposite filaments.

OUR TEAM

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