AEROSPACE ENGINEERING

DIMEAS - Smart Thermal Management and Structural Response of Aerospace Components

Funded By	Dipartimento DIMEAS
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Context of the research activity	The research explores smart thermal management solutions for thin-walled aerospace components, combining advanced sensing, control strategies, and digital twins to mitigate thermoelastic effects. The activity is part of the AMPERE project, funded under the MUR FIS 2 programme.
Objectives	This PhD research investigates innovative thermal management solutions and their impact on the structural response of thin-walled and composite aerospace components. Modern electrified aircraft and space systems require precise and responsive thermal control to maintain structural integrity and operational performance under severe thermal conditions. Thin-walled and composite structures such as wing skins, fuselage panels, payload-support shells, satellite panels, and battery enclosures are particularly sensitive to thermal gradients, leading to deformation, stress accumulation, or thermoelastic instabilities. The project integrates three main activities: 1) Smart thermal management systems: design of active and passive cooling strategies tailored to thin-walled structures; integration of sensors, smart materials, and embedded actuators for distributed thermal and structural monitoring; development of adaptive thermal control strategies using model-based or machine-learning techniques. 2) Structural response modelling of thin-walled composites: prediction of thermoelastic distortions, thermal stresses, and nonlinearities; assessment of stability and fatigue under fluctuating thermal loads; coupling of thermal management systems with shell/plate formulations for thin-walled components. 3) Experimental validation and digital twins: use of dedicated test benches to measure thermal and structural response; validation of digital twin and digital thread approaches developed in AMPERE;

	demonstration of real-time optimization strategies for thermal–structural performance. Applications include hybrid-electric propulsion systems, battery enclosures, electric motor housings, satellite bus panels, and thermally sensitive instrument supports. Outcomes of the research will contribute to safer, more efficient, and thermally resilient aerospace systems.

Skills and competencies for the development of the activity	Knowledge of structural mechanics, composites and thin-walled structures. Interest in thermal management, sensors, and control systems. Experience with FEM, programming, and experimental work is advantageous.