AEROSPACE ENGINEERING

MUR DM 117/CIRA - Multi-disciplinary methods and tools for the conceptual and preliminary design of sustainable hypersonic vehicles

Funded By	C.I.R.A. - CENTRO ITALIANO RICERCHE AEROSPAZIALI SCPA MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]
Supervisor	VIOLA NICOLE - nicole.viola@polito.it
Contact	VIOLA NICOLE - nicole.viola@polito.it
Context of the research activity	The PhD program deals with the development of a multidisciplinary methodology and the related integrated digital tool for the conceptual and preliminary design of hypersonic aircraft, with dual-mode ramjet propulsion and hydrogen as fuel, and of its mission, considering both technology demonstrator and civil/military transport missions. In addition to purely technical performance, the methodology allows to estimate the environmental and economic sustainability of the vehicle. Progetto finanziato nell'ambito del PNRR – DM 117/2023 - CUP E14D23001970004
	The PhD program deals with the development of a multidisciplinary methodology and the related integrated digital tool for the conceptual and preliminary design of hypersonic aircraft, with dual-mode ramjet propulsion and hydrogen as fuel, and of its mission, considering both technology demonstrator and civil/military transport missions. The methodology and digital model exploit engineering and numerical-theoretical methods to predict performance in terms of aerodynamics, aero-thermodynamics, propulsion, emissions and flight mechanics and to provide with the estimation of size, mass and power characteristics. In addition to the purely technical performance, the methodology allows to estimate the sustainability of the aircraft both from an environmental point of view for chemical and noise emissions, and from an economic point of view through life cycle cost analysis. The methodology allows to assess the technical feasibility and the sustainability of the vehicle and its mission, in compliance with system and mission requirements. The use of hydrogen as fuel is crucial to obtain better propulsive efficiency

Objectives	and to contribute to the de-carbonization of the atmosphere. It is also important to underline how the technologies for optimizing hydrogen combustion and for minimizing NOX and H2O emissions are applicable to more conventional subsonic aircraft propulsion systems up to the supersonic regime. Case-studies of past projects co-funded by the European Commission (LAPCAT, HEXAFLY, HEXAFLY-INT, STRATOFLY) will allow to fine-tune and validate the methodology and the integrated digital tool regarding aerodynamic efficiency, stability and trimmability estimates, of the aero-propulsive balance, of the combustor emissions, etc. Finally, the developed tool will be used in more applicative case-studies starting from the propelled hypersonic demonstrator project underway at CIRA. The proposed topic therefore fits perfectly within the PNRR Mission 4C2 "From Research to Business", Investment 3.3, responding to the innovation needs of CIRA in the field of sustainable hypersonic aircraft design. Furthermore, the proposed theme is in line with both Mission 1 of the PNRR "Digitalization, Innovation and Competitiveness in the Production System", promoting the digital transition of design processes of complex systems, and with Mission 2 "Renewable Energy, Hydrogen, Network and Mobility Sustainable", focusing attention on a sustainable hydrogen aircraft with repercussions on other flight regimes in the aerospace sector.

Skills and competencies for the development of the activity	Multidisciplinary design methodology. High-speed vehicles and technologies integration. Environmental and economic sustainability of high-speed systems.