ENERGETICS

MUR DM 117/Morfo Design - Virtual Engine Model Development for Multi-Scale High-Fidelity Simulation of Component and Fluid/Structure Interaction

Funded By	Morfo Design srl [P.iva/CF:06861960489] MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]

Supervisor	SALVADORI SIMONE - simone.salvadori@polito.it

Contact	

Context of the research activity	MUR DM 117/Morfo Design - Virtual Engine Model Development for Multi-Scale High-Fidelity Simulation of Component and Fluid/Structure Interaction in High-Pressure Turbine Stages This research addresses technical and scientific issues associated to the development of a "virtual engine" model for high-fidelity simulation of component and fluid/structure interaction in high pressure turbine stages. The final goal of the activity is to simulate aero-engine flows by coupling different solvers that consider the appropriate scale of each phenomenon, from inertial to integral scale, thus using high-fidelity methods. Progetto finanziato nell'ambito del PNRR – DM 117/2023 - CUP E14D23001950004

	Recent trends in gas turbine design aim at increasing efficiency and specific power, thus reducing pollutant emissions. Irrespectively of both the selected cycle (Brayton-Joule or Zeldovic-Neumann-Doring) and of the design strategy (artificial neural networks or adjoint methods), there is the need for high-fidelity methods that can confirm gas turbine performance and reliability in realistic configurations, while reducing the costs associated to experimental activities. The development of “Virtual Engine” models is a challenging task supported by several funding actions, including Next-Generation EU that is declined in Italy through the Spoke 6 on “Multiscale Modelling and Engineering Applications” of the “HPC, Big Data and Quantum Computing” national center, which includes the most relevant Italian aerospace industries.

Objectives	The present project aims at developing a reliable strategy to study the performance of a cooled High-Pressure Stage turbine stage at engine-like conditions. More in detail, the state-of-the-art methodologies will be packed up to consider all the primary features of such component, namely non-uniform time-dependent boundary conditions, blade row interaction, fluid-structure interaction, and secondary air systems. As far as the latter is concerned, both internal cooling (e.g., serpentine rib-roughened channels, impingement jets, pin fins) and external cooling (e.g., film cooling) on blade and end-walls will be accounted for, including the impact of cavity flows on the blade heat transfer and secondary flows development. Concerning the numerical approach, it is necessary to develop a methodology that allows for simulating all the relevant turbulent scales in an industry-oriented way. In fact, Large-Eddy Simulation of the main-flow coupled with the analysis of the thermal behavior of turbine solid parts and with the Secondary Air Systems is a multi-scale problem that requires the definition of both appropriate time scales and turbulence treatments to be effectively accomplished. Thanks to the continuously increasing available computational resources and to the development of GPU-based algorithms for fluid dynamics, the present activity paves the way to the definition of an approach to multi-scale and multi-component analysis in turbomachinery that is beyond the current state-of-the-art. The proven track record by the research group led by Prof. Misul from DENERG of Politecnico di Torino in the component interaction field will merge with the experience of Morfo Design SRL in numerical modelling of turbomachinery flows to develop a three-years project during which the above-mentioned problems will be faced and solved. The interest by Morfo Design SRL, which supports aerospace industries in the analysis and design of turbomachinery components, proves the scientific and industrial relevance of the proposed activity. Moreover, the support by Prof. Andreini from DIEF of Università di Firenze will provide the necessary information about realistic conditions, as well as geometries for which extensive experimental campaigns have been carried out. The activity will take advantage of possible secondments at relevant research centers like Von Karman Institute for Fluid Dynamics, which is partnering with the consortium in several ongoing EU projects.

Skills and competencies for the development of the activity	Basic knowledge of technical characteristics of gas turbines, with special interest in turbine aerodynamics and film cooling. Basic knowledge of Computational Fluid Dynamics (with commercial tools, preferably ANSYS Fluent or CFX, preferably but not necessarily in heat transfer analysis). Basic knowledge of the English language to proceed with the reading of scientific literature.