MECHANICAL ENGINEERING

PNRR - Integrated methods of design and validation of electric vehicle powertrain including NVH performance

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Context of the research activity	The aim of this research is the definition of a design and validation methodology that includes vibro-acoustic aspects in the early phases of electric powertrain design. PNRR M4C2, Investimento 1.4 - Avviso n. 3138 del 16/12/2021 - CN00000023 Sustainable Mobility Center (Centro Nazionale per la Mobilità Sostenibile) – CNMS - CUP E13C22000980001
Objectives	During vehicle drivetrains development, efficiency and NVH (Noise, Vibration, Harshness) requirements increasingly need to be met in addition to service life and durability aspects. Even though purely electric powertrains have simpler layouts than conventional ones based on thermal propulsion, the adaptation of the design methods is not straightforward and need to be redefined. The change of the operating conditions involving higher speed of the prime mover and the absence of masking noise from the engine have a relevant influence on the dynamic and vibro-acoustic performance assessment. More specifically, high-frequency tonal noise, mainly caused by electromagnetic excitation and gear meshing, may annoy and degrade the comfort perceived by people on board, impairing the vehicle level NVH performance. Therefore, it becomes increasingly important to fully understand how excitations from the powertrain, which can be electromagnetic or mechanical in nature, transmit through the system and radiate noise from the structure, in order to be able to optimize the powertrain for noise and efficiency without compromising performance. In this framework, the contribution of this research activity is to develop design and validation methods for e-powertrains, using an integrated approach that allows to incorporate the interaction of the different contributing factors early in the design phase, foreseeing design changes to both the source of the excitation and the structural components of the system and so preventing costly changes in development phase. This integrated design

	methodology requires a computer aided engineering (CAE) approach with a full system model, along with expertise in noise and vibration, electric motor and drive, gear train. Industrial partners will provide a case study for the simulation and experimental validation of the powertrain system. The research program is conceived in accordance with the objectives of the National Recovery and Resilience Plan (PNRR), aiming at promoting extended collaboration between the worlds of research and industry. More specifically the doctoral program will contribute to the activity of Spoke 13 - Electric Traction Systems and Batteries (ETSB) of the National Centre for Sustainable Mobility.

Skills and competencies for the development of the activity	The skills that the candidate should have to develop the research activity are: experience on experimental testing of transmission systems, signal processing and fault detection, basic knowledge on modelling and simulation of electro-mechanical systems, vibration and noise, problem-solving attitude, computer skills and interest in interdisciplinary aspects.