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Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2024

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Department Name: Mechanical Engineering

Research topic:

- ☐ MSCA-PF Research Area Panels: CHE_Chemistry
- ☐ ECO_Economic Sciences
- X ENG_Information Science and Engineering
- ☐ ENV_Environmental and Geosciences
- ☐ LIF_Life Sciences
- ☐ MAT_Mathematics
- ☐ PHY_Physics
- ☐ SOC_Social Sciences and Humanities

Brief description of the Department and Research Group (including URL if applicable):

Department: **https://www.mecc.polimi.it/** Mission: With its large-scale state-of-the-art technological infrastructure and research facilities, broad theoretical, methodological and technological knowledge, international reputation and successful alumni, the overall mission of the Department of Mechanical Engineering is to deliver world-class research and education in Mechanical Engineering, with particular focus to industrial applications.
Research group: Vehicle design and Testing Group. The research activities developed by the members of the group, through collaborations with national and foreign companies and universities are mainly aimed at testing and optimization of vehicles and their components. Number of Full Professors: 2. Number of Associate Professors: 2. Number of Assistant Professors: 2. Number of PhD students: 11.

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TITLE of the project:
NVH of electric powertrain for heavy-duty vehicles.

Brief project description:

The carbon emissions target set by the EU commission under the landmark European Climate Law aims to reduce greenhouse gas emission by 55% by 2030. Aligned with this vision, the UK government has announced to phase out ICE engines between 2030 and 2035.

Electric trucks are an important part of the decarbonising plan to achieve sustainable road-freight transport. To encourage the uptake of electric vehicles in freight transport, the European Commission has recently revised the EU's CO2 regulation for trucks and buses: In particular, new trucks and coaches must cut their CO2 emissions by 90% in 2040, and 100% of city buses must be zero-emissions in 2030. Following the increasing demand, several manufacturers have launched full electric commercial vehicles. The design of electric vehicles has been mainly focused on the integration of electric powertrain (including motor, inverter, battery pack) in existing designs replacing the ICE powertrain with minimal changes.

The life expectancy of a heavy-duty (HD) vehicle can exceed 1 million miles, and the average age of commercial trucks on the road is about 14 years. Often these miles are driven over demanding duty cycles. Therefore, the assessment of the electric powertrain requires the investigation of the structural response under realistic service conditions and power requirement to understand the effects of the demanding service on each component of the vehicle, including motor and transmission.

The two main vibration and noise sources of the electric powertrain system are the motor and the speed reducer. The electromagnetic and gear-meshing forces can cause structural vibration and noise. The requirements for lighter and more compact electric powertrain are also driving the development of integrated solution which are more complex to assess in terms of vibration and coupling effects.

Vibrations in electrical machines are mainly generated by electromagnetically excited sources (magnetostriction and Maxwell forces) and mechanical sources. Sources of electromagnetic vibrations have the cogging torque, torque ripple, and time varying traction. Sources of mechanical vibration have rotor dynamic, rotor unbalance, bearings and flexible shaft.

NVH simulation methodology for electric powertrain consists in coupling the 2D electromagnetic model used for the design of electromagnetic parts and the 3D powertrain structure models for NVH simulation. Although the 3D simulation technology on the powertrain structure remains like that used for long time for ICE engines, the main limitation is represented by the multi-physics of the simulations required to assess the response and estimate the excitations.

High-fidelity models of electric motors and transmission components can be used to produce data suitable to implement Reduced Order Models (ROM) and develop a flexible platform with which investigate the NVH response of different configurations of electric powertrain and find optimal designs.