



# PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 39th cycle

## PARTENARIATO PNRR Research Field: TRANSITION TOWARDS FREIGHT TRAIN TRANSPORTATION

### Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

### Context of the research activity

#### Motivation and objectives of the research in this field

The transition towards green and sustainable mobility of people and goods represents an interesting opportunity for tackling the problem of greenhouse emissions. Transportation is estimated to generate 25% of the total amount of annual CO<sub>2</sub> emissions in the world. Promoting goods transportation through railways is also one goal of PNRR as well as the improvement of the railway network and its digitalization. Engineers should enhance the overall performance of freight trains, making rail transportation cheaper, faster, safer and more appealing to road transportation, at least over long distances. Using longer and heavier freight trains represents a simple way to reach the target as the overall railway capacity increases. However, such trains pose concerns due to large coupling forces and power demand. Also, technical research revealed safety issues determined by mass and braking power distribution along the trainset. At the same time, new technologies offer plenty of opportunities. Power generators can be installed on freight wagons, guaranteeing the energy required for monitoring the vehicle status (brakes check, predictive maintenance, derailment detection,...). Longer trains require more locomotives that can be profitably coordinated to control coupling forces and exploit regenerative braking. In addition, DAC (Digital Auto Coupler) will enable several new features: automatic coupling/decoupling of wagons, power supply distribution along the train, and distributed braking. The research aims at investigating the potential



	<p>of new technologies to boost freight train transportation.</p> <p>The research activity is financed within the Sustainable Mobility Center (<i>Centro Nazionale per la Mobilità Sostenibile - CN MS</i>) - Spoke 4 (Rail Transportation - <i>Trasporto ferroviario</i>) as part of the National Plan for Recovery and Resilience (PNRR, M4 C2 <i>Dalla ricerca all'impresa</i>).</p> <p>Norms of reference:</p> <p>CUP: D43C22001180001 - D.D. 1033 del 17/06/2022</p> <p>D. D. 3138 del 16/12/2021 rettificato con D.D. 3175 del 18/12/2021 Avviso pubblico per la presentazione di Proposte di intervento per il Potenziamento di strutture di ricerca e creazione di "campioni nazionali" di R&amp;S su alcune Key Enabling Technologies da finanziare nell'ambito del Piano Nazionale di Ripresa e Resilienza, Missione 4 Componente 2 Investimento 1.4 "Potenziamento strutture di ricerca e creazione di "campioni nazionali di R&amp;S" su alcune Key Enabling Technologies" finanziato dall'Unione Europea - NextGenerationEU.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The core of the research will be the development of an Hardware-in-the-Loop (HiL) test bench. This last will include components of the braking system (distributor, reservoirs, brake cylinders), and a complete interface between two adjacent wagons. This interface will be conceived to host a traditional buffers-hook configuration or a DAC. The test bench will allow for characterizing and comparing the performance of wagon components. Monitoring systems could also be tested before their implementation on a real wagon. A model of the dynamics of an entire trainset will be developed in parallel and interfaced with the test bench through a real-time board. The real braking and the coupling systems will be driven by the numerical simulation; the numerical model will receive as feedback real pressures in braking cylinders</p>



	and real coupling forces. The HiL test bench coupled with the trainset model will then be used to analyse and optimise the performance and safety of new long freight trains.
<b>Educational objectives</b>	At the end of the programme, the candidate will be an expert in freight train dynamics with particular focus on monitoring systems, traction/brake force distribution and optimization, performance of different coupling systems. The candidate is expected to develop knowledge on the DAC technology that is expected to dramatically change rail transportation. She/he will know the architecture of braking and coupling systems and will also gain significant experience in real-time simulation.
<b>Job opportunities</b>	<p>Considering the topic of the research and the expertise developed, the candidate will find job opportunities in railway field. The experience on HiL test bench, real-time applications and monitoring devices can be of interest for other sectors of mechanical engineering.</p> <p>UNIFI and Mercitalia are involved in the research project.</p> <p>Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared to Master of Science holders in the same field.</p>
<b>Composition of the research group</b>	<p>1 Full Professors                  2 Associated Professors                  0 Assistant Professors                  0 PhD Students</p>
<b>Name of the research directors</b>	Prof. Stefano Melzi

<b>Contacts</b>	
For questions about scholarship/support please contact <a href="mailto:phd-dmec@polimi.it">phd-dmec@polimi.it</a>	

<b>Additional support - Financial aid per PhD student per year (gross amount)</b>	
<b>Housing - Foreign Students</b>	--
<b>Housing - Out-of-town residents (more than 80Km out of Milano)</b>	--



Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

**Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information**

Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 5.707, 13.

Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 700 euro/month - net amount).

Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.