



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

**PNRR 117 Research Field: ANALYSIS AND DEVELOPMENT OF AN INNOVATIVE SYSTEM  
FOR 4D IMMERSIVE AUTOMOTIVE AUDIO APPLICATIONS BASED ON ELECTRODYNAMIC  
SHAKERS**

<b>Monthly net income of PhDscholarship (max 36 months)</b>
<b>€ 1400.0</b>
In case of a change of the welfare rates during the three-year period, the amount could be modified.

<b>Context of the research activity</b>	
<p><b>Motivation and objectives of the research in this field</b></p>	<p>Nowadays, the car cabin is extensively used as a listening environment for various audio programs, such as music, video soundtrack, navigation system instructions, telecommunications, and warning sounds. Moreover, during the last decade, there has been an increasing desire of different occupants of a car to implement personalized seat entertainment. As an example, this led to the development of innovative active solutions to create independent listening zones. In this context, audio system manufacturers have experimented with increasingly innovative solutions to meet and raise customer expectations. Recently, one of the most interesting challenges is the development of 4D systems, capable of combining Hi-Fi audio systems with devices for generating vibrations, extending the passenger’s perceptive experience. The research program aims at defining, developing and implementing this solution, focusing in particular on the electrodynamic shaker and its coupling with the car seat. The PhD scholarship is awarded by ASK industries, within the research project between ASK and PoliMi.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<ul style="list-style-type: none"> <li>•Modelling of the shaker dynamics</li> <li>•Finite element simulation of structural dynamics of the shaker-seat coupled system</li> <li>•Physical acoustic modelling of the car compartment,</li> </ul>



	<p>based on finite element simulation</p> <ul style="list-style-type: none"> <li>•Characterization of the acoustic properties of the compartment interior elements</li> <li>•Cabin interior noise and seat vibration simulation based on vibroacoustic coupled models</li> <li>•Indoor/outdoor testing and model validation</li> </ul> <p>The candidate shall contribute to the development of advanced simulation tools. He/she will take part in experimental activities, to collect the necessary data for the advancement of the research and to allow for the validation of the proposed numerical models.</p>
<p><b>Educational objectives</b></p>	<p>The candidate will acquire high-profile skills and will be working on one of the most significant and challenging problems in acoustic engineering, dealing with both theoretical and experimental methodologies. He/she will become an expert in advanced sound field modelling and experimental testing, including signal processing and system identification. The candidate is supposed to provide original contributions to the development and experimental validation of innovative simulation tools.</p>
<p><b>Job opportunities</b></p>	<p>Future job opportunities are primarily in the automotive field (especially in NVH and entertainment area), i.e. R&amp;D departments of automotive industries (including automobile manufacturers and vehicle component suppliers in general). Besides this, job opportunities comprise national and international academic and non-academic institutions and organizations, engaged in innovation, research and technical development.</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>
<p><b>Composition of the research group</b></p>	<p>1 Full Professors                  1 Associated Professors                  1 Assistant Professors                  1 PhD Students</p>
<p><b>Name of the research directors</b></p>	<p>Prof. Roberto Corradi, prof. Francesco Ripamonti</p>



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

<b>Scholarship Increase for a period abroad</b>	
Amount monthly	700.0 €
By number of months	6

<b>National Operational Program for Research and Innovation</b>	
Company where the candidate will attend the stage (name and brief description)	ASK INDUSTRIES S.p.A.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Institute of Sound and Vibration Research, University of Southampton
By number of months abroad	6

<b>Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information</b>
<p>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.</p> <p>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.</p>