



PhD in MODELLI E METODI MATEMATICI PER L'INGEGNERIA / MATHEMATICAL MODELS AND METHODS IN ENGINEERING - 38th cycle

**PNRR_352 Research Field: NUMERICAL SIMULATION OF FREE-SURFACE FLOWS IN
INDUSTRIAL MIXING PROCESSES**

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**

Mixing plays a crucial role in many industrial processes for the production of different (plastic, rubber or composite) material compounds. In particular, continuous mixing technologies are typically preferred when high production rates are required. In the framework of an ongoing collaboration with Pirelli Tyre s.p.a., the MOX laboratory has developed innovative numerical tools able to increase the role of modeling and simulation in the design and optimization of continuous mixing technologies. The research activity that will be carried on during this PhD will build upon the non-conforming methods currently developed for single fluid flows coupling them with suitable numerical techniques for the treatment of two-fluid free-surface flows, such as, e.g., the Volume of Fluid (VOF) method or the Level Set (LS) method. The choice of this development direction is motivated by the fact that the strongest simplifying assumption that is made in the current setup is that the mixing machines are considered in a completely filled status. The extension of the model to cover the free-surface case is not straightforward. In particular, the treatment of suitable interface and boundary conditions to deal with the so-called triple point (where the fluid/air interface meets the boundary) should be carefully investigated, in particular in the context of a non-conforming boundary approximation. The proposed activity meets the objectives of the National Recovery and



	<p>Resilience Plan (PNRR) concerning the M1C2 Mission (Digitalization, innovation and competitiveness of the production system). In particular, this research contributes to the PNRR aim to increase knowledge and competencies on advanced simulation and big data as a key enabling technology. As already experienced in previous joint projects between MOX laboratory and Pirelli Tyre, this research activity will foster the interaction with the technical staff of the industrial partner, allowing an effective technology and competence transfer on advanced numerical methods and simulation tools between academy and industry.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The aim of the PhD project is to develop and analyze innovative numerical schemes for the numerical simulation of free-surface non-Newtonian fluids occurring in different mixing technologies. The research will focus on the approximation of the nonlinear partial differential equations governing this kind of flows as well as particle tracking tools for the evaluation of mixing indices to quantify the mixing capabilities of the different technologies. Particular attention will be devoted to the accuracy, stability and computational efficiency properties of the proposed numerical schemes in order to overcome the limitations of standard commercial software.</p>
<p>Educational objectives</p>	<p>The PhD student will develop specific competencies in the field of mathematical and numerical modeling for complex industrial applications by working in an academic research group and collaborating with an industrial partner. In particular, an internship of at least 6 months at Pirelli Tyre s.p.a is planned, where the student will have the possibility to strongly interact with the R&D and technical staff of the industrial partner.</p>
<p>Job opportunities</p>	<p>Main opportunities in the job market include Universities, Research Centers, R&D departments of engineering companies.</p>



Composition of the research group	5 Full Professors 6 Associated Professors 4 Assistant Professors 15 PhD Students
Name of the research directors	Nicola Parolini, Marco Verani

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)			
	1st year	2nd year	3rd year
Housing - Foreign Students	1500.0 € per student	0.0 € per student	0.0 € per student
max number of financial aid available: 3, given in order of merit ..			
Housing - Out-of-town residents (more than 80Km out of Milano)	--		

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

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Pirelli Tyre
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): financial aid per PhD student per year</p> <p>1st year: max 1.902,38 euros 2nd year: max 1.902,38 euros 3rd year: max 1.902,38 euros</p> <p>The PhD students are encouraged to take part in activities related to teaching, within the limits allowed by the regulations. 1 individual PC per student + several shared PC.</p> <p>Access to one cluster with 32 processors and 384 GB RAM, and to several multi-processor servers and 1 individual desk per student are granted.</p>