POLITECNICO DI MILANO

PhD in MODELLI E METODI MATEMATICI PER L'INGEGNERIA / MATHEMATICAL MODELS AND METHODS IN ENGINEERING - 40th cycle

PNRR 630 Research Field: DATA-DRIVEN MODEL REDUCTION FOR INDUSTRIAL MIXING

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0 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. Specifically, continuous mixing technologies are typically preferred when high production rates are required. In the context of two PhD project (one concluded and one ongoing) carried out in collaboration with Pirelli Tyre S.P.A., the MOX laboratory has developed in the past 5 years 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 has the ambitious objective of developing numerical acceleration strategies based on scientific machine learning techniques or model order reduction methods within the numerical tools for the simulation of polymeric mixing processes.The choice of this research direction is motivated by the emerging role of Scientific Machine Learning (SciML) techniques in improving the modeling and simulating capabilities of complex problems in many different contexts. The proposed activity meets the objectives of the National Recovery and 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.
Methods and techniques that will be developed and used to carry out the research	The aim of the PhD project is to develop and analyze innovative data-driven numerical strategies for the simulation of polymeric mixing processes. The research will investigate the application in this industrial context of non-intrusive reduced order models. This family of techniques, which includes data driven and projection-based methods as well as more recent SciML approaches such as operator learning, are able to identify the low-dimensional structure of problems governed by parametric partial differential equations, by extracting patterns from training data of high-fidelity numerical simulations. The development of these approaches will focus on the acceleration of the flow equations governing the fluid-dynamics inside the mixers. Since the final goal of this research is the characterization of the mixing capabilities of the different mixing technologies, particular attention will be paid in the identification of innovative strategies for the definition of mixing indexes, possibly exploiting compressed representations.
Educational objectives	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. Moreover, the PhD student will spend a period of at least 6 months in a research institution abroad.
Job opportunities	Main opportunities in the job market include Universities, Research Centers, R&D departments of engineering companies. The previous PhD enrolled in the same industrial collaboration has been hired by the industrial

	partner.
Composition of the research group	5 Full Professors 11 Associated Professors 7 Assistant Professors 19 PhD Students
Name of the research directors	Proff. Nicola Parolini,Marco Verani,Stefano Pagani

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

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
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
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
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 1st year: max 2.038,16 euros 2nd year: max 2.038,16 euros 3rd year: max 2.038,16 euros 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. Access to one cluster with 32 processors and 384 GB RAM, and to several multi - processor servers.