POLITECNICO DI MILANO

PhD in INGEGNERIA GESTIONALE / MANAGEMENT ENGINEERING - 38th cycle

PNRR_352 Research Field: CYBER-PHYSICAL SYSTEMS FOR SMART OPERATIONS AND MAINTENANCE IN INDUSTRIAL PLANTS

Monthly net income of PhDscholarship (max 36 months)
€ 1450.0 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	Today, the on-going digital transition claims to bring about a change in manufacturing towards a smart management and control built on Cyber-Physical Systems (CPSs). This is aligned with what is expected and required by the Mission 1 of the "Piano Nazionale di Ripresa e Resilienza (PNRR)" objectives on "Digitization, innovation and competitiveness" especially for what regards the production systems in the manufacturing sector. These expectations and requirements are addressed by this research project, aimed at inducing an innovation built on the technologies of CPSs specifically applied to support the Operations and Maintenance of production systems. Relying on a blend of technologies (such as Internet of things, Smart sensors, Big Data and AI, and advanced simulation), the Cyber-Physical integration will be a key enabler to a higher competitiveness of the manufacturing companies, by hosting intelligence and modeling capabilities actionable during the manufacturing operations. A Smart Manufacturing practice is envisioned as expected result, and this will allow to reinforce the role of intelligence, modeling and simulation in a cross-domain approach where the decisions occur across different management and control areas. As different benefits of Cyber-Physical integration are widely discussed in the scientific literature, it is now time to focus on the evaluation of such transformative concept in industrially relevant environments where both machines

	and production systems are embedding the above said capabilities. Framed in this context, this research will investigate the use of CPSs in industrial plants, focusing on Operations and Maintenance. Thus, the manufacturing system will embed capabilities due to an integrated set of artifacts spanning from the intelligence and modeling for Prognostics and Health Management (PHM) of machines, to implement predictive maintenance, to the intelligence and modeling for production management of the production system, for its optimal and efficient operations. The research will consider such a cross-domain scenario by analysing the needs of a manufacturer in the mechanical sector supported by the provision of modelling and data analysis capabilities in a value chain perspective. Positive impacts on productivity and efficiency of Operations and Maintenance, and sustainable performance in terms of energy and material efficiency, will be the major impacts. This will make manufacturing performance as a whole oriented to value creation for the business and environmental aspects.
Methods and techniques that will be developed and used to carry out the research	The following methodologies will be applied in the research project: 1) literature analysis in order to map the situation of research at national and international level; 2) design and development of Cyber-Physical integration with the proper allocation of intelligence and modeling capabilities at the different factory levels; 3) implementation of field studies in the form of action researches to allow the evaluation of the new Operations and Maintenance practice resulting from the Cyber-Physical integration; 4) assessment and validation of the developed models and Cyber-Physical integration architecture through experimental campaigns and experts' judgements.
Educational objectives	In the context of "Piano Nazionale di Ripresa e Resilienza (PNRR)", this scholarship promotes the competence required by the currently on-going transitions, having a major focus on the digital transition. High-level competence and skills will be developed in order to deal

	with applications in production contexts of Key Enabling Technologies required by the Cyber-Physical Systems implementation. On the whole, the research aims to contribute to a high-skill profile that is able to: • analyse, integrate and contribute to the development of the body of research on CPSs in production environment; • analyse and evaluate the Smart Manufacturing practice resulting from CPS implementation; • develop models and capabilities in order to support decision making in Operations and Maintenance domain.
Job opportunities	The opportunities for a PhD graduate in this research area are manifold, in terms of professional development in: • research and development in the fields of industrial operations and maintenance, with specific interest for challenges of the digital transition; • advisory and consultancy for those companies that aim to develop the Smart Manufacturing practice, building upon the IT-driven transformation of manufacturing systems: the PhD graduate will be the right person to lead digital transition projects in manufacturing companies, or may be hired by consultancy companies which accompany manufacturing companies in their transitions.
Composition of the research group	3 Full Professors 1 Associated Professors 7 Assistant Professors 10 PhD Students
Name of the research directors	Macchi M., Polenghi A., Negri E.

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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	725.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Consorzio Intellimech
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	The PhD student will spend a period of at least 6 months abroad to interact with researchers and participate in joint activities potentially foreseen in the project, according to specific needs. Indeed, the project is highly interdisciplinary, and this favors the collaboration with foreign research centers where the candidate can acquire in-depth knowledge on the theme.
By number of months abroad	6

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

Funding for educational activities: 4.900,00 Euros for three years.
Teaching assistantship: 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.
Desk availability: shared use Computer availability: individual use