



PhD in INGEGNERIA GESTIONALE / MANAGEMENT ENGINEERING - 40th cycle

THEMATIC Research Field: HUMAN-MACHINE INTERACTION IN PRODUCTION AND LOGISTICS FOR SMART AND SUSTAINABLE MANUFACTURING

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	<p>Smart and sustainable manufacturing is a key transformative goal where human-centric approaches can be promoted by key enabling technologies in the cyberphysical systems as supporting means. This leads to complement humans and machines in the industrial working environment. Artificial intelligence methods and models are particularly relevant in this context, as they are expected to provide the capabilities for an intelligent human-machine interaction. This is promising for the potential of an effective interaction in different tasks related to the production and logistics. This is particularly relevant also in the light of the challenges that manufacturing is bringing about, with flexibility, reconfigurability and adaptability to meet the changing requirements from the market. Indeed, requirements for customized and personalized production are currently emerging, and production and logistics tasks are required to adapt to the related changing requirements.</p> <p>Given this challenging and evolving context, the overarching goal of this PhD scholarship is to address the work of the operators within the human-machine interaction. Innovation is built on the collaborative relationship between humans and machines as key parts of the socio-technical industrial facilities and workplaces. A human-centric approach is taken in the development of such innovation: it will promote smart and sustainable manufacturing in the shop floor, leading to build human-centric manufacturing processes and systems. Herein, the</p>



	<p>extensive adoption of Artificial Intelligence methods and models is envisioned, with the aim to monitor the work and state of the operators to improve the interactions with machines.</p> <p>The specific objectives are correspondingly defined, with a particular emphasis on the operators at the center of the study:</p> <ul style="list-style-type: none"> •Study of artificial intelligence methods to model the operators with special emphasis to cognitive workload and learning in operational contexts of humanmachine interaction; •Development of artificial intelligence methods and models to monitor human-machine interaction with a human-centric manufacturing approach, with particular focus on the tasks of the operators; •Programming and application of methods and models in selected experimental settings, inclusive of the Industry 4.0- Cognitive Ergonomics (CORE) Laboratory and selected field studies;
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>Design Science Research is the main methodological approach in order to frame the development of this PhD research; furthermore, considering the experimental requirements of the work, the investigation leads to the adoption of selected experimental research methodologies. The entire research project then consists of the following major project phases:</p> <ul style="list-style-type: none"> •Literature review, to map the situation of the research at national and international level, with the end purpose to build a robust knowledge background and to identify targeted gaps for contribution to scientific knowledge; •Design, development and programming of artificial intelligence methods and models based on the requirements for an intelligent human-machine interaction with a human-centric manufacturing approach, with a particular focus on the tasks of the operators; this is the part of the research that, at its core, requires a



	<p>Design Science Research process to fit the engineering design needs;</p> <ul style="list-style-type: none"> •Experimentation on intelligent human-machine interaction; experimental research methodologies should then fit the research objectives, the designed artefacts from the prior phase, and the chosen experimental settings, which may range from controlled experiments in laboratory to field studies in specific industrial environments provided by multiple projects; •Building on the experimentation in the identified experimental settings, assessment and validation of the developed methods and models, and of their application in a range of different contexts where human-machine interaction is adopted.
<p>Educational objectives</p>	<p>High-level competence and skills will be developed at the nexus between human factors and artificial intelligence methods and models, considering the requirements for human centricity in manufacturing. On the whole, the research aims to contribute to a high-skill profile that is able to:</p> <ul style="list-style-type: none"> •Develop critical thinking capabilities regarding the opportunities and challenges opened by digital transition to human-centric manufacturing; •Analyze, integrate and develop Artificial Intelligence applications as an aid to improve the operators well-being and performance in manufacturing systems; •Design research projects building on the joint adoption of design science research and experimental research methods to successfully achieve specific objectives; •Understand and apply experimental research methods in the context of human-machine interaction, in the light of different experimental settings;
<p>Job opportunities</p>	<p>The opportunities for a PhD graduate in this research area are manifold. Professional development can be expected</p>



	<p>majorly in:</p> <ul style="list-style-type: none"> •research and development in the fields of industrial operations, with specific interest for challenges of human-centric manufacturing and the role of digital technologies as means to this end purpose; •advisory and consultancy for companies that aim to invest on smart and sustainable manufacturing, with a particular emphasis on the improvement of the working environment for the operators in the interactions with machines; the PhD graduate will be the right person to lead the transition projects in manufacturing companies, leveraging digitalization for the implementation of human-centric approaches, or, in the role of a consultant, to accompany manufacturing companies in their transition projects.
Composition of the research group	4 Full Professors 2 Associated Professors 8 Assistant Professors 18 PhD Students
Name of the research directors	Marco Macchi, Luca Fumagalli

Contacts
marco.macchi@polimi.it; luca1.fumagalli@polimi.it

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Funding for educational activities for the three years is available. 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.

- Involvement in projects: "For the overall development of their capabilities, PhD candidates will work on synergical projects to favour empirical data collection and network development for their career. Projects will give candidates the opportunity to work in group (peers and other senior professors)".
- Teaching and tutoring: "If coherent with the development of their doctoral program, the PhD candidate will have the opportunity to be involved in: teaching activities, tutoring to master students, tutoring to PhD candidates for administrative processes".

Funding for educational activities: 6.100,00 Euros for three years.