IMT SCHOOL FOR ADVANCED STUDIES LUCCA

Attachment 1.A

Project title: Management of Digital Transformation in the Global Monitoring Decision Support System

Company: Leonardo SpA, https://www.leonardo.com/

Project description

From a training point of view, the PhD student will attend specialized advanced courses provided by the PhD programme of the IMT School for Advanced Studies Lucca on topics concerning enabling technologies for Industry 4.0, the management of digital transition processes and their effect on ecological transition and environmental impact. Where necessary, this training activity can be enriched by additional external courses or by seasonal schools on specialistic topics aimed at developing the research thesis. In addition to the courses of a scientific-technological nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the foundations of academic entrepreneurship, on the management of intellectual property, on communication techniques for dissemination and valorization of research and on critical thinking. The skills acquired will be aimed at developing the research project and training a researcher for his future job placement both in academia and in technical-scientific and managerial roles in public and private companies.

In the research project, the PhD candidate will focus on the study of innovative methodologies, processes and technologies for a new model of "command, control and decision support", in extremely complex and multi-domain areas such as critical infrastructures, territorial protection and city management.

The new methodologies and emerging technologies to support digital transformation allow a redefinition of the paradigms used up to now for the monitoring and governance of complex systems both from the point of strategic planning and the operational management of accidents, in particular during crisis situations.

The research activity will investigate the application of cognitive tools for the understanding of complex multi-domain and interdependent phenomena typical of global monitoring, and the generation of operational responses. Possible models of cognitive dynamic geo-visualization will also be studied for the representation of information in the context of an automatic system to support decisions.

During the study, the applicability and scalability of Digital Twins for the monitored context will also be analyzed as an alternative and/or in synergy with classical data-driven models.

The research product will concern publications also of an applied nature on the new X-2030 Global Monitoring platform developed by Leonardo S.p.A.

The successful candidate will have the opportunity to carry out their research directly at the premises of Leonardo S.p.A. for a period of 6 to 18 months.

IMT SCHOOL FOR ADVANCED STUDIES LUCCA

Attachment 1.B

Project title: Paper mill sludge: new valorization opportunities

Company: Lucart S.R.L., https://www.lucartgroup.com/

Project description

From a training point of view, the PhD student will attend specialized advanced courses provided by the PhD programme of the IMT School for Advanced Studies Lucca on topics concerning enabling technologies for Industry 4.0, the management of digital transition processes and their effect on ecological transition and environmental impact. Where necessary, this training activity can be enriched by additional external courses or by seasonal schools on specialistic topics aimed at developing the research thesis. In addition to the courses of a scientific-technological nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the foundations of academic entrepreneurship, on the management of intellectual property, on communication techniques for dissemination and valorization of research and on critical thinking. The skills acquired will be aimed at developing the research project and training a researcher for his future job placement both in academia and in technical-scientific and managerial roles in public and private companies.

Regarding the research project, the PhD student will concentrate his/her activities on the theme of reuse and enhancement of dried sludge from paper production starting from waste paper. The objective of transforming waste from the paper production cycle into a by-product is of great interest to the industrial sector of the country, due to the considerable amount of material involved which is around 40,000 tons per year only for the Lucca area. Attempts have been made since 1990 to reuse this material in construction and agriculture. The doctoral thesis aims, starting from the background of studies and research conducted by the industrial partner Lucart S.p.A., to carry out a holistic study on the recycling of dried sludge in order to identify innovative solutions for their reuse and explore what has already been done in the international field to understand how technologies already developed and applied in other contexts can be adapted, modified and integrated into the production cycles of Lucart and potential partners. These solutions will be guided by research on materials, starting from the unique properties of dried sludge, to identify possible applications of potential impact on the market. In parallel, for each technological solution identified, a life cycle assessment will be conducted and, for the most promising solutions, market barriers, possible strategic partners for the marketing of new products, the presumable annual volumes that the various supply chains will be analyzed, as well as the reference regulatory framework. Solutions, proposals, technologies that envisage partnerships with Tuscan companies or companies linked to the territory will be privileged. The final objective of the doctorate is the development of general projects that include at least a brief description of the production processes identified, accompanying the study with estimates of the plant costs to be implemented and the related management costs.

The research product will concern publications on the methods proposed for the recycling of the material and its characterization from a circular economy perspective. These results can be achieved both with traditional methods of an experimental nature, and through innovative methods of numerical simulation conducted with virtual testing techniques. The latter represent one of the main enabling technologies for Industry 4.0 aimed at reducing the time associated with laboratory experimentation and the development of new products and materials.

Attachment 1.C

Project title: Development of new technologies for the hydrogen supply chain: simulation methods aimed at the industrialization of devices for the production, storage and use of hydrogen

Company: Ne.m.e.sys S.R.L., https://nemesysenergy.com/

Project description

From a training point of view, the PhD student will attend specialized advanced courses provided by the PhD programme of the IMT School for Advanced Studies Lucca on topics concerning enabling technologies for Industry 4.0, the management of digital transition processes and their effect on ecological transition and environmental impact. Where necessary, this training activity can be enriched by additional external courses or by seasonal schools on specialistic topics aimed at developing the research thesis. In addition to the courses of a scientific-technological nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the foundations of academic entrepreneurship, on the management of intellectual property, on communication techniques for dissemination and valorization of research and on critical thinking. The skills acquired will be aimed at developing the research project and training a researcher for his future job placement both in academia and in technical-scientific and managerial roles in public and private companies.

With regard to the research project, the PhD student will focus their activities on the mechanics of materials for the hydrogen supply chain, in cooperation with the company Ne.m.e.sys srl, a research company specialized in development of technologies for the hydrogen supply chain, 30% owned by Nuovo Pignone Holding spa of the international Baker Hughes group. Baker Hughes with Ne.m.e.sys is committed to fostering the energy transition and guaranteeing continuity for society's energy needs, targeting the world goals by 2050.

Manufacturing technologies are developing innovative fuel cells to produce low-cost hydrogen. For example, the United States Office of Energy Efficiency & Renewable Energy has set the goal of 2 $/kg by 2025 and 1 $/kg by 2030, through a path to net zero carbon emissions. In Italy, the cost of producing hydrogen at industrial sites is around 6 Euro/kg and the price of hydrogen in a pumping station is around 13 Euro/kg. New materials and technologies used for fuel cell membranes are expected to have a positive impact on reducing manufacturing costs. Likewise, their use in combination with intermittent sources can lead to more efficient distribution networks, significantly reducing delivery costs.

This PhD position aims to develop an interdisciplinary approach for an accurate assessment of the operational characteristics of hydrogen fuel cell technologies and storage systems, integrating materials research when considering realistic usage operations and accurate assessment of the life cycle (LCA). Research on computational mechanics will be exploited to develop models for the evaluation of the durability of components (membranes, porous materials, etc.) used in standard and innovative fuel cells, towards a more accurate evaluation of their duration and costs. Knowledge of electrical networks and intermittent renewable sources (eg wind and photovoltaic) will be used to evaluate the operational performance in the reduction of disturbances on the energy distribution network. The result of the technical information will be integrated with a refined LCA approach, in order to support informed decisions of policies and decision makers on key topics ranging from the operation to the end of life of fuel cells.

The research product will concern publications on the proposed methods for the mechanical characterization of materials and devices for the production of hydrogen. These results can be achieved both with traditional methods of an experimental nature, and through innovative methods of numerical simulation conducted with virtual testing techniques. The latter represent one of the main enabling technologies for Industry 4.0 aimed at reducing the time associated with laboratory experimentation and the development of new products and materials.

Attachment 1.D

Project title: Predictive modeling and digital innovation: implications on the business model and on the measurement of company performance

Company: Selene S.p.A., Selene S.p.A.

Project description

From a training point of view, the PhD student will attend specialized advanced courses provided by the PhD programme of the IMT School for Advanced Studies Lucca on topics concerning enabling technologies for Industry 4.0, the management of digital transition processes and their effect on ecological transition and environmental impact. Where necessary, this training activity can be enriched by additional external courses or by seasonal schools on specialistic topics aimed at developing the research thesis. In addition to the courses of a scientific-technological nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the foundations of academic entrepreneurship, on the management of intellectual property, on communication techniques for dissemination and valorization of research and on critical thinking. The skills acquired will be aimed at developing the research project and training a researcher for his future job placement both in academia and in technical-scientific and managerial roles in public and private companies.

With regard to the research project, the PhD student will focus the activities on the study and exploration of business modeling or the creation of models by which to understand the processes themselves with a perspective focused on the digital dimension. The modeling is based on symbols and conventions through which business processes can be simulated to evaluate different scenarios and govern business trends also from a predictive point of view: the physical world and the digital world will be increasingly interpenetrated and the line of separation and demarcation will become tenuous until it completely disappears.

The research product will concern publications, also of an applied nature, on the methods proposed for the digitization of the business model. These results can be achieved both through the use of traditional methods of analyzing business models and performance, and through the use of innovative digital simulation methods that involve the use of virtual managerial testing, virtual test data management and other techniques. The latter are also configured as enabling technologies for Industry 4.0 aimed at improving the efficiency of the corporate decision system with regard to both the water and energy issues, and environmental sustainability and the innovation process.

IMT SCHOOL FOR ADVANCED STUDIES LUCCA

Attachment 1.E

Project title: Virtual prototyping methods for calculating the performance of sails and load-bearing hydrodynamic appendages of high-performance yachts

Company: ToolsPole OÜ, https://toolspole.com/

Project description

From a training point of view, the PhD student will attend specialized advanced courses provided by the PhD programme of the IMT School for Advanced Studies Lucca on topics concerning enabling technologies for Industry 4.0, the management of digital transition processes and their effect on ecological transition and environmental impact. Where necessary, this training activity can be enriched by additional external courses or by seasonal schools on specialistic topics aimed at developing the research thesis. In addition to the courses of a scientific-technological nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the foundations of academic entrepreneurship, on the management of intellectual property, on communication techniques for dissemination and valorization of research and on critical thinking. The skills acquired will be aimed at developing the research project and training a researcher for his future job placement both in academia and in technical-scientific and managerial roles in public and private companies.

Regarding the research project, the PhD student will concentrate his/her activities on the development of virtual prototyping methods for the calculation of the performance of sails and load-bearing hydrodynamic appendices of high performance yachts. These appendices are able to generate sufficient lift to lift the hull, and with it completely out of the water, to obtain a drastic reduction in drag, with a considerable increase in the speed of the hull. Given the relative novelty of the introduction of this solution, there are currently no consolidated design techniques for yachts that sail in foiling conditions. A multidisciplinary approach will therefore be used that will allow to identify an adequate physical mathematical model of the problem under examination. The hydrodynamic performance of foils and sails depends on the trim of the boat and on the actual shape that the appendices and the sails assume in operating conditions and, the latter, in turn, depend on the loads and fluid dynamic forces that water and air exert on the structure. Therefore, suitable predictive models will have to include aspects related to rigid body dynamics in three dimensions, structural dynamics, and fluid dynamics, and their mutual interaction. Furthermore, in order to properly adjust the sails and the mobile appendices of the foils in order to obtain the desired performance, notions from the theory of optimal control will be necessary.

The research product will concern publications on the proposed methods for the simulation of the aero/hydrodynamic behavior of the hull and its sails and appendices, as well as on the numerical discretization methodologies of the resulting governing equations, and control problems.

The innovative methods of numerical simulation conducted with virtual testing techniques, object of this project, represent one of the main enabling technologies for Industry 4.0 aimed at reducing the time associated with the experimentation and development of new and more efficient forms, materials and products.

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Attachment 1.F

Project title: Digital libraries for cultural heritage: an interdisciplinary approach for project management

Company: FRANCO COSIMO PANINI EDITORE S.p.A., https://www.fcp.it/

Project description

From a training point of view, the PhD student will attend specialized advanced courses provided by the PhD programme of the IMT School for Advanced Studies Lucca on topics concerning enabling technologies for Enterprise 4.0, the management of digital transition processes and their impact on business models and society. Where necessary, this training activity can be enriched by additional external courses or by participation in seasonal schools on specialist topics aimed at developing the research thesis. In addition to the courses of a scientific-technological nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the foundations of academic entrepreneurship, on the management of intellectual property, on communication techniques for dissemination and research exploitation, and on critical thinking. The skills acquired will be aimed at developing the research project and training a researcher for his future job placement both in academia and in technical-scientific and managerial roles in public and private companies.

With regard to the research project, the PhD student will focus his/her activities on the theoretical and practical study of technologies and process methodologies for the creation of digital libraries in the field of cultural heritage, through the study of best practices and a series of concrete case studies.

The following different interdisciplinary thematic areas will have to be addressed and deepened:

- standards, methodologies and technologies for the digitization of cultural heritage;
- standards, methodologies and technologies for the description and meta-dating of digital objects;
- technologies, platforms and standards for the computerized management of digital assets;
- technologies, platforms and standards for online publication and enhancement of digitized cultural heritages;
- project management and management methodologies with particular attention to the relationship with the various stakeholders.

The research product will concern publications on the proposed study methods, the design and implementation of a digital library, from the digitization and description of cultural objects, to online publication for its use.

Attachment 1.G

Project title: Meta-workplace and management: implications on company organization and business model

Company: Intesa Sanpaolo Innovation Center, https://www.intesasanpaoloinnovationcenter.com

Project description

From a training point of view, the PhD student will attend specialized advanced courses provided by the PhD program of the IMT School for Advanced Studies Lucca on topics concerning enabling technologies for Industry 4.0, the management of digital transition processes and their impact on business models and society. Where necessary, this training activity can be enriched by additional external courses or by participation in seasonal schools on specialist topics aimed at developing the research thesis. In addition to the courses of a scientific-technological nature, the student will develop soft skills through seminars offered by the IMT School for Advanced Studies Lucca on the foundations of academic entrepreneurship, on the management of intellectual property, on communication techniques for dissemination and research exploitation, and on critical thinking. The skills acquired will be aimed at developing the research project and training a researcher for his/her future job placement both in academia and in technical-scientific and managerial roles in public and private companies.

With regard to the research project, the PhD student will focus his/her activities on the macro-theme relating to "The development of meta-workplace". Specifically, the development of applications in Metaverse is rapidly growing and research on the subject is still in its infancy. The Metaverse, by changing the mode of functional and social interaction between individuals, could contribute to drastically redesign the environments and ways of working in a corporate context (e.g., enhancement of communication and virtual collaboration thanks to avatars and virtual environments). Therefore, one of the most immediate challenges of the Metaverse is the development of a meta-workplace.

So far, the scientific state-of-the-art -mainly related to the macro-theme of Virtual Reality and Augmented Reality- has investigated the nature of virtual interactions, in particular by exploring the characteristics of immersion or sensor-motor integration, but no work has characterized systematic and direct impact of the Metaverse in organizational and business contexts, which we could define as a Meta-workplace. In a first phase, the doctoral student will carry out a careful analysis of the literature on the Metaverse and a comparison between the solutions so far devised for the introduction and application of the Metaverse in a business context. Subsequently, the PhD student will face the task of characterizing -from a behavioral, organizational and neuroscientific point of view- the possible configurations and applications of the meta-workplace and the application of the Metaverse in relation to the various domains in terms of marketing, human resources, organizational and business applications, such as manager-customer interaction and customer engagement, business processes and business performance, interaction with corporate, improvement of the emotional dimension from the interaction between team members.

The research products will concern publications and applications on the methods proposed for the characterization and application of the Metaverse in organizational and business contexts, the preparation of reports, papers that can be used as: elements of knowledge dissemination within the ISP group; updates on the latest technological and market developments; preparatory activity for the development of a commercial proposition for the Metaverses. The project will allow to test the ergonomics of the meta-workplace, as it will allow us to understand how different configurations of the Metaverse manage to impact the functional, social and corporate interaction of team members and to correlate interactions with performance.

In summary, the project makes it possible to design -on the basis of neuro-cognitive and behavioral evidence-the workplaces of the future. The different configurations of the Metaverse are elements that can be defined

by the management and therefore represent levers for managing the team, but also for possible areas of collaboration with external Corporate for business issues.