



# PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 39th cycle

**PNRR 118 PC Research Field: STRUCTURED METHODS BASED ON REVERSE  
ENGINEERING AND BLOCKCHAIN TECHNOLOGY FOR PRESERVING CULTURAL  
HERITAGE**

<b>Monthly net income of PhDscholarship (max 36 months)</b>
<b>€ 1400.0</b>
In case of a change of the welfare rates during the three-year period, the amount could be modified.

<b>Context of the research activity</b>	
<b>Motivation and objectives of the research in this field</b>	<p>Over the past few years, the cultural heritage sector has undergone significant transformations as a result of the utilization of ICT technologies for various objectives, including but not limited to preservation and communication. Specifically, reverse engineering and blockchain technologies can offer several opportunities for preserving and protecting cultural artifacts and traditions. For instance, by using reverse engineering techniques, experts can analyze and replicate cultural artifacts (such as buildings, monuments, works of art, artifacts and so on) that may have been lost or damaged over time. Blockchain can then be used to record the ownership, provenance, and history of these replicated artifacts, ensuring that they are properly preserved and protected. In addition, these technologies can also be used to protect cultural heritage from damages, thefts, and illicit trades. By acquiring the virtual replica of the cultural content and creating a tamper-proof record of ownership and provenance, reverse engineering and blockchain can provide an effective way to verify the authenticity of cultural artifacts and prevent their unauthorized sale or transfer. Furthermore, eXtended Reality (XR) are technologies that can leverage these virtual replicas to enable the dissemination of cultural heritage information and knowledge among various communities and stakeholders. As example, Virtual Reality and Augmented Reality are more and more used to improve traditional</p>



	<p>exhibition or to create new virtual ones. However, so far, the used approaches have been rather disparate, and there hasn't been any systematic methodology proposed to oversee the complete process. On these bases, the main objective of this research is to define and develop a new structured method and the related guidelines for the process of the acquisition and certification of cultural artifacts and use of the obtained virtual replica in XR applications for dissemination activities. The new structured method will describe and organize the cultural and technological elements that characterize the research topic and will provide guidelines for the process of acquisition and certification of cultural artifacts and the use of the obtained virtual replica in XR applications for dissemination activities.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The research methodology will consist of mixed methods, in which theoretical and experimental activities will be combined in an integrated research approach for a depth understanding of the research problem. Specifically, theoretical activities will concern the analysis of the current situation, the categorization of cultural and technological elements that characterize the research topic, and the definition of the new structured method. Experimental activities will concern the testing activities of the new structured method and the related tools through real case studies. These will be developed taking advantage of the qualified and specific operational and scientific structures for study and research activities provided to the PhD student, which are the Reverse Engineering and the Virtual Prototyping &amp; Human Modelling Laboratories at the Department of Mechanical Engineering of Politecnico di Milano, the Gianfranco Ferré Research Center of Politecnico di Milano, the Virtual World Heritage Laboratory at the Indiana University, and the equipment provided by the AerariumChain (part of WEREA) company.</p> <p>More in detail, the research methodology can be defined through several main steps that can be described as follow:</p>



	<ul style="list-style-type: none"> <li>- Critical analysis of current situation, both through bibliographic references and real case studies, in the areas of reverse engineering, blockchain, eXtended Reality, etc;</li> <li>- Analysis and categorization of the cultural and technological elements that characterize the research topic and contribute to the overall process;</li> <li>- Definition of the new structured method in which the analysed elements will be organized with logical links and the guidelines for the process of acquisition and certification of cultural artifacts and creation of XR applications for dissemination activities will be integrated;</li> <li>- Testing activities of the structured method and the related tools through real case studies that will be developed in collaboration with companies and cultural institutions. Those testing activities will be carried out both for the evaluation of the completeness and usability of the developed method and guidelines;</li> <li>- Refining of the structured method and the guidelines on the basis of the results of the testing activities.</li> </ul>
<p><b>Educational objectives</b></p>	<p>The educational objectives of the research activities are the acquisition of the advanced theoretical knowledge and empirical skills for design and the development of interactive exhibitions and innovative tools and applications for learning. This includes the acquisition of theoretical and practical knowledge about Reverse Engineering, Blockchain, and Virtual Prototyping techniques and tools.</p> <p>Moreover, the PhD student will:</p> <ul style="list-style-type: none"> <li>- acquire new skills about the in-depth analysis of specific topics related to representation disciplines;</li> <li>- acquire new knowledge about scientific research methods in Reverse Engineering, Blockchain and Virtual Prototyping research areas;</li> <li>- improve scientific dissemination skills, to share the obtained scientific results, through appropriate communication means. Specifically, the PhD student will learn methods and tools for the enhancement of research results through an adequate circulation of the results pursued according to the "Open science" and "FAIR Data"</li> </ul>



	principles.
<b>Job opportunities</b>	<p>The main job opportunities are towards research - in universities or public and private research institutions - or professional activity in other entities, public or private, national or international. Indeed, it is possible to affirm that this research area is increasingly growing in recent years, both for what concerns academic research and professional practice. Several universities and companies are working in the digital archaeology and conservation fields. Digital archaeology uses reverse engineering techniques to analyze and reconstruct archaeological sites and artifacts, while digital conservation uses the 3D models of cultural heritage objects and artworks obtained using reverse engineering techniques to preserve them. Companies working in this field (such as the AerariumChain - part of WEREA - company) are also working on the development of blockchain-based systems for managing cultural heritage resources and funding. In addition, insurance companies are approaching the use of blockchain-certified 3D models to evaluate possible damages to cultural heritage objects and artworks. Finally, several companies and museums are working on the XR for the Cultural Heritage field to create Virtual and Augmented reality experiences of museums and exhibitions that allow visitors to explore cultural heritage sites and artifacts in immersive ways. These companies (or museums' departments) use 3D modeling and reverse engineering techniques to accurately represent historical sites and objects.</p> <p>More in general, our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary than Master of Science holders in the same field.</p>
<b>Composition of the research group</b>	<p>3 Full Professors              8 Associated Professors              3 Assistant Professors              13 PhD Students</p>
<b>Name of the research directors</b>	Prof.ssa Monica Bordegoni

**Contacts**



Phone: 02 2399 8260 Email: monica.bordegoni@polimi.it

For questions about scholarship/support please contact phd-dmec@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	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)	WEREA S.r.l. - Aerariumchain
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Indiana University, Luddy School of Informatics, Computing and Engineering - Virtual World Heritage Laboratory (VWHL)
By number of months abroad	6

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

Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 5.707,13.

Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. 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.