



PhD in ARCHITETTURA, INGEGNERIA DELLE COSTRUZIONI E AMBIENTE COSTRUITO / ARCHITECTURE, BUILT ENVIRONMENT AND CONSTRUCTION ENGINEERING - 39th cycle

PNRR 118 PNRR Research Field: IMMERSIVE SIMULATION OF PREDICTIVE SCENARIOS RELATED TO CLIMATE CHANGE; DIGITAL SIMULATION AND EVALUATION TOOLS FOR ARCHITECTURAL AND URBAN RETROFITTING.

Monthly net income of PhDscholarship (max 36 months)

€ 1275.0

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

The AEC sector (architecture, engineering, and construction sector) needs a paradigm shift, to adhere to processes that have positive balance with respect to the environment they transform from the design stage. At present the processes of a construction does not develop nor in a design phase nor on building site a necessary process of environmental mitigation. Promoting sustainable developments is mandatory to reduce the impacts of climate change as included in one of the **PNRR Mission, green evolution and ecological transition (M2C1, M2C3, M2C4)**.

To provide a construction process with the least impact on the environment in terms of footprint is an unfulfilled goal: a building site is antithetical to the concepts of preserving the ecosystem or promoting sustainable development. Although developments in BIM modelling and digital Twins go deeper, there is not - a mandatory green - simulation to direct choices for to reduce the overall footprint or even to improve compromised urban situations. The regulations also do not provide yet levels of mitigation that the building can put in place.
(https://www.mase.gov.it/sites/default/files/archivio/allegati/PNRR/SEC_21.06.22.pdf).



	<p>Despite these Standards bodies have long established the possibility of verifying and measuring environmental damage: principles and guidelines consistent with international standards on LCA - Life Cycle Assessment ISO 14040 and ISO 14044 were developed by UNI EN ISO 14064-1:2019. However, a greener development of the construction and environment can be promoted with the support of simulation as a tool more accessible in virtual or augmented reality environments.</p> <p>Objectives:</p> <ul style="list-style-type: none"> •to grow the ability to improve the simulation processes of the environmental footprint in the construction testing scenarios including ventilation, flow paths, CO2 concentrations, dynamics between constructions implementing digital and smart tools; to grow the green BIM dimension (Green BIM); •to offer, by means of simulation and the creation of virtual representations, proposals for the construction site to mitigate its impact to comply with microclimate; to simulate and visualise in demonstrative virtual environments the climatic transformations brought about by the new settlement, directing them towards a positive balance; •to simulate improvements in the passive cooling systems of the planned structures and the environment in which they are inserted by offering the possibility of demonstrative immersive virtual environments; and •to visualise in immersive environments the mitigation processes with a view to promoting transparency in the valorisation of the project and the seriousness of the implementing companies.
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The integration of BIM and sustainability aims to respond effectively to the shortage of energy resources and the challenges of environmental degradation related to the construction sector but while the digitization of construction, optimization of processes, and organization</p>



of the performance of the completed building has taken off with the BIM methodology, there is no integrated application for green programming, for a Green BIM. The development of a green Gantt (diagram developing phases of a green mitigation) should follow the same timescale as the development of a construction Gantt starting from the design phase to the building site itself. For these consideration the **first part** of the research will develop a rapid analysis of BIM processes to clarify how a green dimension is possible in the BIM phases. The relevant regulations will be used to check the path and the steps within the process for impact mitigation from design phase to realization.

A **second part** will focus on the analysis of existing computational resources and simulation tools on climate variation regarding single buildings or the environment: <https://www.ladybug.tools/dragonfly.html>, wind patterns, use of parameters for microclimatic mitigation <https://www.envi-met.com/>, calculation of green resources to be deployed, quality of the circular economy. The development will foresee the use and implementation of applications for the simulation and visualization in Virtual, Augmented and Mixed reality (this last one tested with small, medium and large-scale design) of the green dimension.

To facilitate the decision-making processes of green sustainability of the worksite and construction operations. The One-Works company will host the selected PhD candidate for **a mandatory period abroad of 6 months**.

One-Works is an Italian company with a branch in London, known for large BIM design projects and retrofitting culture. Here the PhD candidate will have the opportunity to gather research experience to make it viable in the design processes that are its core business. Integrated design the assessment of the 'impact of the built environment throughout the life cycle, from site start-up to maintenance operations to building decommissioning and demolition will be experimented with immersive visualization and interaction tools. The group will test the idea of a green Gantt and workflow proposals by combining them with BIM modelling processes, collecting considerations on a green dimension of the model to see how to implement them in



	the different stage of the design process. All the experiments will be used with a view to raise the firms awareness of the relationship between design, construction and footprint.
Educational objectives	<p>Development of computational skills, visual scripting and coding for simulation and representation Improvement in Virtual Reality (VR) and Augmented Reality (AR) applications for simulation processes on environment and construction. Awareness to be shared in companies for reduction of footprint in construction with skills and methods.</p> <p>The group has already developed high skills in green building and health building certifications, environmental/social impact assessment and permittingsustainability and esg due diligence, air quality consulting and engineering energy, daylight and acoustic modelling and auditing through the BIM activity.</p>
Job opportunities	<p>Construction companies looking for reduction of the footprint of their construction will look for candidates with the produced skillsPublic asset companies engaged in the renovation of their properties will require the candidate's expertise for the mitigation of their interventions as Town administration.</p> <p>New rule can be provided for future regolamentation.</p>
Composition of the research group	<p>0 Full Professors 2 Associated Professors 1 Assistant Professors 1 PhD Students</p>
Name of the research directors	prof. Cecilia Maria Bolognesi

Contacts	
<p>Prof. Cecilia Maria Bolognesi email: cecilia.bolognesi@polimi.it</p>	

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	637.5 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	
By number of months at the company	0
Institution or company where the candidate will spend the period abroad (name and brief description)	One-Works company - 91-94 Lower Marsh, South Bank SE1 7AB London, UK
By number of months abroad	6

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

Additional support:

Budget for the research activity (only for positions supported by scholarship): total amount Euro 5197.60 per student.

In detail:

- 1st year Euro 1732.53
- 2nd year Euro 1732.53
- 3rd year Euro 1732.53

Additional information about the organization and regulations of ABC-PhD programme can be found in the Regulations for the 39th Cycle of ABC-PhD: download is available at link: <https://www.dottorato.polimi.it/corsi-di-dottorato/architettura/architettura-ingegneria-delle-costruzioni-e-ambiente-costruito>

Additional information about ABC department and ABC-PhD programme: available at link: <https://www.dabc.polimi.it/> **Desk availability:** The ABC department provides non-permanent desks to be temporarily booked in common PhD rooms.

This scholarship is funded by the PNRR national programme under the research line on "Generic PNRR topics" in D.M. 118. This means that the owner of the position will be obliged to submit periodical reports about her /his activity.