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VII INTERNATIONAL CONFERENCE

Luis Palmero
Graziella Bernardo
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EDITORS



PROCEEDINGS

ECOLOGICAL INTELLIGENCE FOR A CIRCULAR AND TRANSFORMATIVE ARCHITECTURE

Valencia, 05 June 2026 | Universitat Politècnica de València

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ECOLOGICAL INTELLIGENCE FOR A CIRCULAR AND TRANSFORMATIVE ARCHITECTURE

Luis Palmero
Graziella Bernardo
Stefania De Gregorio
(Eds.)

edUPV
Universitat Politècnica de València

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Luis Palmero
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Diseño Circular en Acción: a design–build lab for circular living wall systems

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Abstract: the paper presents *Diseño Circular en Acción*, a design–build workshop developed at the Universitat Politècnica de València (UPV) to test circular approaches in living wall systems development. Moving from previous theoretical research on the bioclimatic renovation of Building 1C at UPV, the project aims to translate a green façade design hypothesis into a prototype built with local recycled materials. The workshop is conceived as a methodological device that integrates circular design, nature-based solutions and experiential learning, engaging students in the co-design and self-construction of a disassemblable and adaptable full-scale module. A local material bank, built up from selective demolition processes and recent flood-related recovery, provided the basis for rethinking the design process by allowing materials to define the prototype configuration rather than the other way around. The resulting module operates simultaneously as a technical and pedagogical device functioning as a research-in-action model for replicable circular strategies in climate-vulnerable contexts and highlighting the role of universities in advancing local ecological transition through research-informed teaching practices.

Keywords: nature-based solutions (NBS), living wall systems (LWS), circular economy, co-design, self-construction.

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1. Ecological intelligence and green facades: from strategy to experimentation

We are currently facing an ecological crisis affecting climate, resources and production models. In this scenario, the construction sector, which accounts for around 40% of European energy consumption (European Commission, 2020a), can no longer limit its efforts to improving building performance, it must reconsider its approach to the built environment, interpreting the existing building stock as a reserve of resources and material capital to be transformed. This transition requires a redefinition of design processes oriented toward life extension, disassembly and upgrading of existing buildings (Leising et al., 2018), in line with circular approaches promoting adaptation, reuse and resource regeneration (Kirchherr et al., 2017).

At the European level, these principles are reflected in climate neutrality policies and renovation strategies (European Commission, 2019; European Parliament & Council of the European Union, 2024), as well as life-cycle approaches and secondary raw materials valorization (European Commission, 2020b).

Within this framework, the integration of nature into architecture plays a strategic role. Nature-based solutions (NBS) and, particularly, living wall systems (LWS), act as climate adaptation measures by reducing solar radiation and mitigating surface temperatures (Vox et al., 2018), while also contributing to urban regeneration (European Commission, 2015). The envelope thus evolves from a purely technical barrier into a dynamic device supporting urban biodiversity and enhancing spatial quality.

However, such systems remain constrained by cost, technical complexity and reliance on industrial components. If ecological intelligence implies transforming existing conditions into resources, accessible and reversible strategies based on local recycled materials must be explored.

In this perspective, the present contribution builds upon the renovation pathway initiated for Building 1C at the Universitat Politècnica de València (UPV) (Bernardo et al., 2025), translating a LWS design hypothesis into a full-scale experimental module constructed from locally sourced recycled materials to test circular, adaptive and regenerative practices in the built environment transformation.

2. The workshop as a methodological device

The workshop *Diseño Circular en Acción* emerged from research and teaching activities developed at the Escola Tècnica Superior d'Enginyeria d'Edificació (ETSIE) of the UPV. Previous student research supervised by Prof. L. Palmero and Prof. G. Bernardo, assessed the environmental performance of Building 1C and the potential of LWS as a bioclimatic renovation strategy (Capucci et al., 2013; López Vallés, 2018).

The transition from the design proposal to construction reflects a deliberate methodological choice. Literature shows that hands-on activities enhance technical skills, critical thinking and material awareness (Mackintosh, 2014), while full-scale design–build educational experiences enable direct engagement with material constraints, structural limits of recovered components and the need to adapt design decisions to real construction conditions (Montacchini et al., 2024).

In this case, the workshop goes beyond constructing a 1:1 module of a predefined LWS. It reassesses the system according to the availability of locally recovered materials. The design process is therefore reversed: instead of adapting materials to a technological system, it is the material properties, such as dimensions, form and embedded history, that shape the final configuration.

2.1. Local recycled materials valorization

The module design begins with defining a local material bank, understood as a curated inventory of resources available within the area. The concept, explored in the literature as a strategy to facilitate reuse and the reintroduction of building components into production cycles (Cai & Waldmann, 2019), is here applied as a physical storage of materials derived from selective demolition processes.

The materials intended for the workshop come from Derribos Andrés, a Valencian demolition company that recovers and stores architectural components and reusable objects prior to final demolition. The main categories identified in the warehouse include wooden elements (shelves, doors, boxes), metal components (nets, gates, frames), lightweight containers, ceramic and other heterogeneous waste objects (Figures 1a & 1b).



Figure 1a. Doors and wooden components [Source: authors].



Figure 1b. Gates and metal items [Source: authors].

While some of these materials are restored and resold as antiques, the workshop focuses on marginal and commercially unattractive items, such as disused bedsprings (Figure 2), old gates and damaged boxes, that nonetheless retain structural potential and can be reinterpreted as supporting frames or planting containers for a vegetated wall system.

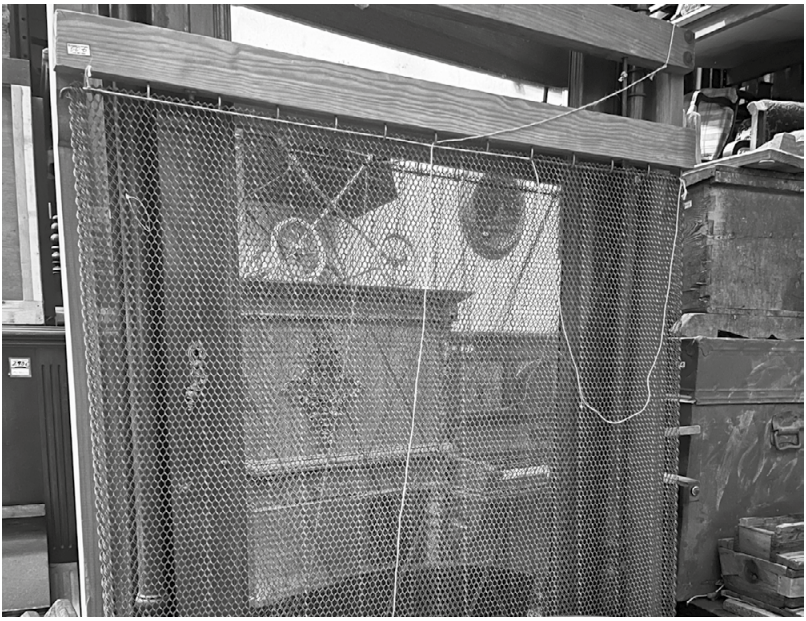

Figure 2. Old bedspring [Source: authors].

Following the October 2024 DANA flooding,[1] the warehouse accumulated additional materials from damaged buildings. The material bank thus becomes not only a stock of secondary resources but also a material archive of extreme climatic events, linking design experimentation to territorial adaptation.

[1] A DANA (Depresión Aislada en Niveles Altos) is an upper-level cut-off low that remains semi-stationary and convey moist, unstable air masses toward the Iberian Peninsula, generating extreme rainfall events. Similar events are currently up to 15% more intense and associated with temperatures up to +3 °C higher than in the past, with the intensification primarily attributed to anthropogenic climate change (Faranda et al., 2024).

From an organizational perspective, the scale of the warehouse makes spontaneous materials selection by students impractical. Therefore, a preliminary technical survey led to the development of an operational catalogue including typologically coherent components for the workshop. This ensures safety, dimensional compatibility and structural suitability while preserving experimental freedom.

2.2. Experiential design-build implementation

Active student involvement represents a central component of the workshop. For this reason, the course was structured as a voluntary activity limited to twelve participants, ensuring manageable coordination and safe on-site operations (Figure 3).



Figure 3. Workshop flyer [Source: authors].

The workshop was promoted through the UPV Centro de Formación Permanente (CFP).[2] Structuring the activity as a non-curricular course allows the involvement of truly motivated students, promoting a learning environment based on active participation and empowerment.

Organized in collaboration with ETSIE and the ETSA (Escola Tècnica Superior d'Arquitectura) model lab, the workshop takes place over two consecutive days following an experiential learning methodology. A theoretical session introduces LWS and circular economy principles and presents the

[2] The CFP is the unit responsible for managing the UPV's non-regulated training offer open to the public (Universitat Politècnica de València, n.d.).

case study of Building 1C and the selected materials, while a second practical phase involves students in the co-design and guided self-construction of a disassemblable, adaptable and reusable prototype. The operational dimension enables participants developing technical skills and critical awareness in transforming waste into resource, within a process where error, on-site verification and design adjustment become part of the learning experience.

3. An ecological and social micro-infrastructure

The experimental module acts as a demonstrative micro-infrastructure allowing the building envelope to be interpreted as a multi-layered ecological system. Its innovative value lies not only in environmental performance, but in the way the system is conceived and implemented. The prototype operates as a form of research-in-action, testing in real conditions the integration of LWS with circular design principles through recycled materials and reversible construction solutions.

At the same time, the workshop activates a social dimension that extends beyond the constructed object. Collective construction, understood as a process of knowledge co-production, transforms the campus into a space of experimentation and strengthens the educational role of the project. Design–build literature recognizes such practices as pedagogical tools capable of raising critical awareness and civic responsibility about environmental (Salama & Patil, 2025) and social impacts.

Integrating environmental performance of LWS, circular design and full-scale educational experimentation the prototype becomes a replicable model, suggesting a transformative architectural practice in which the envelope operates as ecological infrastructure and the construction process itself becomes a research tool.

4. Towards replicable circular LWS models

The experience shows that integrating circular design, self-construction and NBS can generate alternative approaches to existing buildings based on material reuse, construction reversibility and design adaptability. Moving from design to full-scale construction allows testing potentials and

constraints under real conditions, turning the prototype into a technical, economic and environmental assessment tool.

In a climate-vulnerable context, ecological intelligence emerges as the ability to reinterpret available resources and integrate nature and structural reuse within a unified design process.

The module becomes a demonstrator of a different operational logic, in which material constraints become generative opportunities. From this perspective, the prototype represents a starting point for replicable experimentation, suggesting a more active role for architecture, and universities, in supporting local ecological transition.

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