CIRCULAR EDUCATION IN THE ARCHITECTURE SCHOOLS: THE DIDACTIC POTENTIAL OF SUPERUSE IN INDUSTRIAL VOIDS

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Abstract. In a global context marked by the increasing scarcity of natural resources, the construction sector remains one of the most environmentally impactful. This condition calls for a radical rethinking of conventional production models, encouraging a transition from linear approaches to those rooted in the principles of the circular economy, increasingly relevant in architecture. However, their implementation remains limited, hindered by regulatory, procedural, and cultural barriers. It is therefore essential to understand how to train designers capable of acquiring the competencies needed to operate according to circular principles, while developing critical skills to grasp their values and potential. Circular Economy Education (CEE) plays a central role in fostering this paradigm shift and has emerged as a distinct field of study. This paper investigates how architectural education can effectively integrate Circular Economy principles, with a particular focus on teaching material reuse in the context of urban voids. The objective is to identify, through a critical review of innovative educational practices, a set of replicable approaches that facilitate the learning of contemporary circular design models. The research is based on the analysis of teaching experiences and educational pathways adopted by international universities that have incorporated these principles into architectural training. Particular attention is given to pedagogical methodologies focused on the reuse of construction materials and components, with reference to the concept of Superuse, understood as the creative ways that reveal and reinterpret materials. Integrating Circular Economy principles into architectural education requires a transformation not only in content but also in teaching methods. Material reuse labs, interdisciplinary workshops, and collaborations with companies adopting reuse practices emerge as key experiences for fostering a new design ethic. In this context, Superuse stands out as a strategy to promote within academic curricula, transforming resource scarcity into an opportunity to rethink the value of materials.

Keywords: Circular Economy in Architecture; Material Reuse Strategies; Superuse; Architectural Education; Industrial Voids Regeneration.

Introduction

In recent decades, environmental issues have taken on an increasingly central role in the international architectural debate, redefining the ethical, technical, and cultural horizons of the discipline. The climate crisis, the depletion of natural resources, and the growth of construction waste - accounting for roughly one third of all waste produced in Europe (European Commission, 2018) - demand a radical reassessment of the production and consumption models that underpin the building sector.

In this context, the transition toward a circular economy emerges as one of the principal challenges and, at the same time, one of the key opportunities for contemporary architectural practice. (Geissdoerfer et al., 2017, Journal of Cleaner Production, 143, 757–768) (Kirchherr et al., 2018, Resources, Conservation and Recycling, 127, 221–232). When applied to the built environment, circularity opens new possibilities for reducing the sector's environmental impact by promoting strategies of recovery, transformation, and reuse of existing materials. Construction and demolition waste are thus reinterpreted as design resources within a system that seeks to close production cycles and extend the useful life of materials (Norouzi et al., 2021, Journal of Building Engineering, 44), (Krajewska & Siewczyńska, 2025, Sustainability, 17(15)).

One of the urban conditions most suited to the application of circular-economy approaches is that of urban voids: abandoned, underused, or functionless spaces (Pluta, 2017, Biblioteka Regionalisty, 17, 87–95). Far from being mere elements of decay, urban voids can be reinterpreted as circular reserves of material. Integrating the principles of the circular economy into regeneration processes makes it possible to transform them into strategic resources for a sustainable city through practices such as urban mining, design for disassembly, and harvesting, to name a few. Among these are also emerging practices, including that of superuse: a design approach oriented toward the creative reuse of building materials and components, capable of assigning new and unexpected functions to what is typically considered waste. Unlike traditional forms of reuse, superuse highlights both the intrinsic material and immaterial qualities, namely the formal and narrative dimensions, of matter, endowing it with a new purpose. This practice is promoted in particular by the Dutch collective Superuse Studios (van Hinte et al., 2007, Superuse), which combines, in its architectural projects, an approach to sustainable reuse with a cultural reflection on the value of the built environment.

However, fostering a genuine circular transition requires more than innovating design alone; it also demands innovation in education. A circular approach entails a systemic shift that concerns not only construction sites and design practices, but also pedagogical and training models. Schools of architecture, as places where design knowledge is produced and transmitted, are thus called to reflect on how to impart the values and competencies of circularity to new generations of designers. (Renfors, 2024, International Journal of Sustainability in Higher Education, 25(2), 244–262), (Sumter et al., 2020, Journal of Cleaner Production, 282, 124–132).

In this regard, superuse represents a potential educational device applicable to the reuse construction site, which becomes a laboratory for active learning where sensibility, creativity, and operational skills are cultivated. From this perspective, urban voids emerge as potential experimental sites—open spaces in which new practices of transformation and reactivation can be tested. Architecture schools thus assume the role not only of places for professional training, but also of laboratories of cultural innovation, where scenarios of reuse applied or applicable to

urban contexts awaiting new life are explored.

It is within this context that the present research is situated, aiming to explore the didactic potential of superuse through a critical analysis of the training practices promoted by European schools of architecture. To support the investigation, a database of experiences has been compiled, gathering curricular courses, summer schools, and workshops focused on reuse and circular design. This tool is not merely an archive but a dynamic observatory that makes it possible to identify emerging approaches, detect replicable models, and reflect on the role of educational institutions in the transition toward a more conscious and sustainable culture of circular design.

Research Context and Objectives

The database developed within this research is intended to serve as a dynamic observatory of teaching practices related to reuse and superuse in architecture programs across Europe. Rather than functioning as a static archive, it takes the form of an evolving mapping that gathers educational experiences centered on the reuse of building materials and components. This tool not only documents a heterogeneous set of initiatives, but, more importantly, enables their comparative and interpretive reading, bringing light shared or divergent approaches, methodologies, and cultural trajectories.

La costruzione del database si inserisce in un progetto di ricerca dottorale dedicato allo studio del superuso come pratica emergente, con un focus specifico sulla sua rilevanza sia come approccio progettuale sia come strumento pedagogico. La ricerca intende, da un lato, indagare il ruolo della formazione nella diffusione dei principi dell'economia circolare all'interno del progetto architettonico; dall'altro, analizzare come tali principi vengano concretamente tradotti in esperienze didattiche e operative. Il database è stato così concepito come strumento di osservazione e confronto delle modalità con cui le scuole di architettura stanno affrontando l'insegnamento della circolarità, sperimentando pratiche di riuso attraverso modelli formativi che coinvolgono studenti, docenti, materiali di scarto e spazi residuali. In particolare, esso consente di individuare approcci didattici replicabili e di riflettere sul potenziale educativo del riuso applicato ai vuoti urbani come occasione di apprendimento attivo e trasformazione spaziale.

The development of the database forms part of a doctoral research project dedicated to the study of superuse as an emerging practice, with a specific focus on its relevance both as a design approach and as a pedagogical tool. The research aims, on the one hand, to investigate the role of education in disseminating the principles of the circular economy within architectural design; on the other, to examine how these principles are concretely translated into teaching and operational experiences.

For the purposes of this article, attention is directed specifically toward those educational pathways and experiences that involve the reuse of materials derived from demolitions or construction waste associated with abandoned or underused spaces. The industrial urban void, understood as a marginal yet potentially activable space, is considered here not only as an object of the project, but also as a pedagogical device for triggering emerging circular practices, and more specifically, practices of superuse.

From these premises emerges the research question that guides this work: Can the urban void become an opportunity to experiment with circular pedagogical models and to reactivate abandoned industrial sites through practices of superuse?

Methodology

The methodology adopted for this research was structured around the construction and analysis of a database designed to collect and compare educational experiences promoted by European schools of architecture in the field of the circular economy, with a specific focus on reuse practices. The database was conceived as a tool for critical observation, enabling the identification of emerging approaches, replicable models, and design sensibilities within the European academic landscape.

For the selection of case studies, the geographical focus was placed on the European Union, considered relevant in light of its ambitious circular-economy policies (European Commission, 2020, 2024, and 2025). Furthermore, the availability of accessible documentation and the presence of well-established networks and initiatives among European universities such as Erasmus+, COST, ENSA, and EAAE, made Europe a privileged context for gathering the case studies.

The methodological framework adopted is based on a qualitative approach involving a critical reading of the experiences, aimed at identifying recurring patterns, differences, and shared trajectories across the various case studies. Data collection was structured into two phases:

- a preliminary survey of known experiences, conducted through academic sources, institutional websites, and promotional materials for courses. This survey combined the author's prior knowledge and personal networks with a targeted online search using keywords aimed at identifying relevant courses and programs on Circular Economy and material reuse, subsequently tracing them back to the institutions offering them;

- a systematization of the data instrumental in the construction of an interpretative framework to standardize the analytical parameters and allow for comparison across heterogeneous experiences.

This approach made it possible to identify concrete and well-documented cases, ensuring their relevance and alignment with the aims of the research and enabling a comparative and cross-sectional reading of the selected experiences.

Database Structure and Descriptive Parameters

The selected experiences were catalogued using an interpretive framework constructed on descriptive and comparable parameters, organized as follows:

- **Promoting Institution** – Identifying the academic context of reference;

- **Geographical Location** – Identifying the geographical context;

- **Year and Duration** – Observing the frequency and temporal continuity of the initiatives;

• **Type of Activity** – Mandatory or elective curricular course, Bachelor or Master level / Workshop / Summer school / Research project / MOOC;

• **Title and Description of the Activity** – Understanding the context, project scale, objectives, approaches, and materials;

• **Actors Involved** – Students, instructors, companies, institution, or local communities;

• **Tools** – Circular practices adopted;

• **Outputs Produced** – Prototypes, exhibitions, publications, or built realizations.

The organization of these information made it possible to construct a structured overview of the experiences, helping to highlight the specificities of individual cases.

General Overview of the Experiences Mapped in the Database

The database developed within this research brings together a significant selection of educational experiences promoted by European schools of architecture and academic institutions. Although still a work in progress and therefore not exhaustive in absolute terms, the sample offers a representative snapshot of the growing attention that the academic world is dedicating to the circular economy and its related themes, both within curricular teaching and through experimental extracurricular initiatives.

Types of experiences collected

The activities mapped encompass a wide range of formats: from curricular courses to intensive workshops, from international summer schools to applied research projects, and even prototype development and temporary constructions. Many of the observed courses take the form of elective modules within Master's programs, while a significant portion is represented by summer schools and intensive workshops, often organized in collaboration with external actors.

The majority of the experiences combine a theoretical framework with a practical component, which takes the form of design exercises, fieldwork, prototype construction or full-scale realizations. This interplay between theory and practice emerges as a recurring and distinctive feature of the most innovative circular educational experiences.

Differences and similarities

Despite the variety of approaches and contexts, several characteristics are common across the experiences analyzed:

• Centrality of reclaimed materials as both a design resource and an educational tool;

• On-site experimentation, with activities frequently carried out in real or semi-real contexts such as abandoned spaces, urban voids, or decommissioned buildings;

• Active involvement of students, businesses, and local institutions, which transforms the university laboratory into a platform for co-design and interdisciplinary exchange.

The main differences concern:

• The scale of intervention, with exercises ranging from construction-detail explorations to proposals for the regeneration of entire areas;

• The didactic approach and tools employed, reflecting diverse organizational modes and operational strategies.

Most active geographical areas

The surveyed experiences reveal a significant concentration in certain European geographic areas. In particular:

• Switzerland and Netherlands stand out for the high number of initiatives related to reuse and superuse, often developed in collaboration with research centers and leading practitioners in the field;

• Italy and Germany display consolidated and diversified experiences, distributed across university courses and laboratory activities with a strong experimental character;

• Denmark and Austria emerge with specific and isolated projects characterized by a strong interdisciplinary component.

In general, a greater level of activity is observed within academic contexts in Northern and Central Europe, likely due to the presence of more established environmental policies, dedicated research infrastructures, and a design culture already oriented toward sustainability and innovation.

Architecture Schools as Agents for Experimenting with Circular Reuse Approaches

Architecture schools are taking on an increasingly active role as agents of circular regeneration, transforming teaching into a device for research and real-world intervention. Educational experiences thus become micro-practices of urban transformation, capable of linking theory and action, environmental awareness and design experimentation. In this context, urban voids, particularly those of industrial origin, constitute fertile ground for testing new approaches to the superuse of building materials and components.

As noted earlier, urban voids thus become potential opportunities for applying reuse and superuse practices as educational devices for raising awareness and fostering regeneration. The urban void is transformed into an open laboratory; a space for learning and research in which students, instructors, and communities can reinterpret what has been abandoned, assigning new meanings and functions to it. From this perspective, teaching becomes a tool for innovation, bringing the principles of the circular economy into synergy with design experimentation, material research, and environmental awareness. Industrial voids, in particular, naturally lend themselves to such approaches, thanks to their often modular structures and dry-construction systems, which make them genuine "reserve of building materials" that can be drawn upon.

The following sections present a selection of significant experiences that explore the theme of reuse through different approaches and tools, reflecting the different design sensibilities and contexts in which they are situated. Despite their heterogeneity, these examples share a common

orientation toward creative and innovative forms of reuse, in which waste materials from various sources are reinterpreted and redeployed in unexpected ways, often taking on functions completely different from their original ones.

Closing Loops

Closing Loops, a student competition organized by Aalto University in collaboration with the City of Helsinki, represents an experimental construction model developed using materials recovered from demolitions and decommissioned areas. Combining an approach based on urban mining and inter-site synergies, it demonstrates the concrete feasibility of applying circular strategies. The collected materials were stored on the island of Mustikkamaa, where the project was carried out. The project is characterised by a very simple and linear structure, designed to ensure ease of maintenance, considering that the reused materials were between 30 and 50 years old and were employed both structurally. The project took the form of a circular economy applied teaching workshop, the result of collaboration among students, researchers, and professionals, demonstrating the feasibility of implementing synergistic approaches in the recovery and reuse of building materials and components (Fig. 1).

REUSE – Structural Steel & Facades Integration

The Summer School on Circularity in the Built Environment at TU Delft proposes REUSE – Structural Steel & Facades Integration, takes place annually and explores strategies for the structural reuse and integration of decommissioned building elements, such as steel components and industrial façades, reinterpreted as design resources. Students, researchers, and industry representatives, as Superuse Studio, explored the theme of reuse through roundtable discussions, theoretical sessions, and functional visits to buildings that exemplarily implementation of reuse. The core of the activity consisted of design work with disassembled materials, from which various façade prototypes were developed. These prototypes reinterpret waste in entirely innovative ways, demonstrating the technical feasibility of superuse when applied at the building scale through a critical and experimental approach (Fig. 2).

A wooden dome made solely from waste

Developed at ETH Zurich within the Circular Engineering for Architecture laboratory directed by Professor Catherine De Wolf, represents an emblematic example of how research and teaching can be translated into concrete practices of circular architecture. The project consists of the construction of a geodesic dome built entirely from reclaimed materials sourced from a demolition site in Geneva. The process began with the collection of materials from an old car depot in Geneva slated for demolition: timber beams, OSB panels, metal elements, and plastic piping, each originally destined for disposal, were recovered from the site and transported to Zurich. There, students undertook their selection, cleaning, and processing. The wooden beams, for instance, were stripped of nails and foreign objects and then cut into segments suitable for forming the structural elements of the dome. One of the project's innovative aspects lies in the use of digital tools to optimize reuse, through the development of an algorithm capable of adapting the geometry of the dome to the irregular dimensions of the available materials, minimizing waste and enhancing the value of existing resources. Each element of the structure was also equipped with a QR code linked to a digital material passport, an online archive containing data on the origin, characteristics, and traceability of each component. The assembly of the dome was completed in just three days. The wooden beams were connected using custom connectors fabricated from discarded plastic pipes. The result is a structure with strong symbolic and educational value: an ephemeral architecture that demonstrates the possibility of building exclusively with waste materials, transforming what was destined for landfill into a complex, technologically advanced, and sustainable architectural object (Fig. 3).

The database also includes additional educational and research experiences that focus on the theme of reuse applied to underutilised spaces, among them:

- Stricker, E., Angst, M., Brandi, G., Buser, B., & Sonderegger, A. (2023). Case study K.118 – The reuse of building components in Winterthur, Switzerland. ZHAW Zurich University of Applied Sciences / Baubüro in situ AG / RPTU University of Kaiserslautern Landau.

- From Building to Building: Trondheim workshop – Reuse of Local Building Materials for New Structures University of Antwerp. (2023, September).

The experiences discussed in this chapter, which have led to outcomes at different scales—ranging from the entire building to the technological detail and extending to the prototyping of temporary pavilions—demonstrate how schools of architecture, through teaching and research, can function as genuine laboratories of circular regeneration. Urban and industrial voids thus become sites of active learning, where design intertwines with an ethic of material recovery, paving the way for new forms of awareness and for a regenerative and sustainable architecture.

Conclusion

The research presented here, although still in an evolving phase, aims to contribute to the development of an observatory on European educational experiences related to reuse and the circular economy, with the objective of fostering a critical and interdisciplinary dialogue among the various cultures of reuse and, in the medium term, outlining an interpretive framework. The analysis revealed that the dissemination of circular teaching practices displays an uneven geographical distribution: although education on the circular economy is gaining attention across Europe, certain academic hubs stand out as particularly active, where environmental policies and local sensibilities have fostered the development of more structured experimental approaches. This scenario highlights the need to strengthen the exchange network among schools of architecture, promoting a broader diffusion of reuse culture and circular innovation within educational programs.

The core hypothesis underpinning this research is that reuse, understood as a cultural practice even before a technical one, constitutes, today, one of the principal drivers of renewal in architectural design and its

pedagogy. The growing presence of courses, studios, and workshops dedicated to these themes signals a shift in paradigm: architecture is no longer conceived merely as a formal exercise, but as a means to cultivate new sensitivities toward materials, environmental responsibility, and design ethics. In this light, the spread of the experiences mapped can be interpreted as a genuine cultural manifesto, illustrating how the university can become a laboratory for testing new models of design and construction based on reuse, material traceability and process. Across the cases examined, theory, practice, and research intertwine, restoring to education an active role in shaping a circular design culture. Each experience surveyed offers a distinct interpretation of reuse: from recovery materials on urban construction sites to adaptive design strategies based on availability of existing resources. Within this variety, superuse, though not yet defined in a fully consolidated manner, emerges as a transversal approach within circular practices and as a potential pedagogical tool. It encourages experimentation, develops creativity and material awareness, proposing a radical shift in perspective that leads to the revaluation of waste material, its potential role and future use, while fostering a more critical design mindset. The project thus becomes an act of knowledge and transformation, in which learning takes place through doing.

Finally, urban and industrial voids emerge as privileged experimental sites, suspended and available places that offer space, material, and the opportunity to test circular approaches, while simultaneously generating social and cultural value. The experiences examined show how these often marginal areas can become laboratories of educational innovation, capable of bringing together teaching, research, and urban regeneration.

Looking ahead, superuse thus appears as both a methodological and pedagogical lens through which to educate more aware architects, professionals capable of tackle the complexity of contemporary design and contributing actively to the transition toward a truly circular built environment.

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Figures

Figure 1 – Main activities of the experience and outcome: Closing Loops, student competition promoted by Aalto University in collaboration with the City of Helsinki, 2025.

Figure 2 – Main activities of the experience and final outcome: REUSE – Structural Steel & Facades Integration, summer school promoted by TU Delft, 2025.

Figure 3 – Main activities of the experience and final outcome: GLOBE, experience promoted by ETH Zurich within the Circular Engineering for Architecture laboratory, 2022.







FROM INDUSTRIAL SHELL TO CIVIC HEART: THE TRANSFORMATION OF LOCHAL

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Abstract. The transformation of Tilburg's LocHal from a former locomotive repair hall into a public library exemplifies sustainable urban renewal through adaptive reuse. Rather than treating the structure as a mere shell, the project reactivates its historical presence as part of the city's collective memory, introducing a flexible cultural program that repositions the building as a contemporary civic forum. More than a library, LocHal is a public stage that fosters social inclusion, education, and creative collaboration. The architectural intervention balances environmental and social sustainability, offering a powerful alternative to demolition and new construction. LocHal shows how industrial heritage can serve as infrastructure for the future of urban communities.

This paper adopts a critical case study methodology, combining spatial analysis, theoretical research, and architectural interpretation to examine LocHal's regenerative transformation. In addition to its symbolic and social resonance, the project employs circular economy approaches. The transformation demonstrates regenerative strategies through its use of retained steel structures, daylight-optimized glass façades, movable textile systems used for both spatial zoning and daylight control, along with flexible interior spaces that minimize the need for carbon-intensive construction. LocHal illustrates not only symbolic reuse, but also a circular, low-carbon approach that positions architecture as active infrastructure in the metabolism of the city.

Keywords: Adaptive Reuse, urban regeneration, LocHal, library, industrial.

Introduction

The LocHal Library in Tilburg is a place Nicolae Iorga would have described as "beautiful" in the sense used by the famous Romanian historian: a harmonious, whole, complete form, suggested by the Latin formosus (Iorga, 1968). Elements of the old architecture sit in harmony with the new; they enhance one another and form a balanced, coherent whole with a renewed identity. This formal coherence extends into lived experience. Through an atmosphere that can genuinely move one, LocHal belongs to what Peter Zumthor calls quality architecture: "Quality architecture to me is when a building manages to move me" (Zumthor, 2006, p. 11). In this sense, LocHal does not merely preserve traces of its industrial past; it renders them perceptible in a way that evokes the site's memory and creates a living, relevant place for the local community, the wider city, and visitors alike. The resonance of this intervention is also evident in professional recognition. The LocHal Library in Tilburg has received numerous awards: "It was shortlisted for the IFLA/Systematic Public Library of the Year award and winner of the World Building of the Year 2019 at the World Architecture Festival. LocHal has won many other awards for creative reuse, best building, liveability and social cohesion, interior design, habitat, rebirth and conservation (...)" (Boemaars, 2021, Chapter 12, p. 190).

Yet beyond the experiential dimension and the validation of awards, LocHal remains relevant as a case study for debates on adaptive reuse and urban regeneration. The intervention's major value exceeds the narrow frame of the architectural object: it operates as a civic anchor with an urban activation effect. What it achieves at the scale of the city is all the more significant given that, in the past, the building belonged to an ensemble closed to the public—one that separated parts of the city. Against this backdrop, this article pursues two research questions: (1) How does the adaptive reuse transformation of LocHal creates regenerative effects at urban, social, and symbolic levels? (2) How do program decisions and spatial–material strategies contribute to the intervention's circular performance and carbon reduction, while sustaining the site's character and memory? Methodologically, the article develops a critical case study of LocHal through documentary and theoretical analysis, spatial–architectural analysis, and on-site observation.

Adaptive Reuse

Adaptive Reuse is generally understood as the practice through which existing structures—unused or underused—receive new functions and become an alternative to demolition or to simple conservation (as passive preservation), offering buildings the possibility of new stages of development (Wong, 2017). In this way, unused buildings enter new active phases in response to new requirements and needs—new chapters of inhabitation and integration into the life of the neighborhoods and cities to which they belong—supporting the continuity of urban history.

Historically, up to the Industrial Revolution—when demolition and building from scratch became the rule—buildings most often followed a process of re-functionalization, because structure typically outlives function (Cantacuzino, 1989). Before industrialization, buildings were continually reused for pragmatic, functional, and financial reasons (Powell, 1999), and later also for symbolic reasons (Lanz & Pendlebury, 2022). Industrialization accelerated urbanization, overcrowding, and public health crises, which fueled waves of interventions in which "cleaning" and "renewing" the city became legitimate. Land became more valuable than making use of what already existed. The loss of built landmarks—and of entire layers of urban history inscribed in collective memory—generated a reaction and a shift in paradigm: reuse began to be understood as a broader strategy, not only for protecting isolated architectural objects, but for regeneration. Alongside old churches, cathedrals, or manor houses, other building types entered focus: warehouses, industrial sheds, and factories. The entire built stock came to be seen as an economic, social, and ecological resource capable of supporting urban regeneration (Cantacuzino, 1989). The underlying question can be stated as follows: how can an existing structure be used so that it becomes useful and relevant to the city again, without losing the character that gives it value?

Within this framework, Adaptive Reuse gained momentum in the second decade of the twenty-first century. Wong notes that if, in 2008, a Google search for the phrase "Adaptive Reuse" produced few results, in 2022