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A Living Lab

Design, Development, and Implementation of Circular Renovation Strategies

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Abstract

The more than three hundred modular student dormitories at the VUB campus, designed by modernist architect Willy Van Der Meeren in 1972, were once at risk of demolition. Today, they are being repurposed to create a versatile new use. The twelve modules in the project not only serve as a catalyst for preservation but also lead the way in transitioning the remaining buildings to a circular renovation model. The project focuses primarily on preservation (concrete structures and sanitary units) and the reuse of materials both on-site (Fontex panels, concrete elements, and terrace tiles) and off-site (carpet tiles, insulation, lighting, sanitary, and kitchens). We start with a "casco" that meets basic needs and comfort for any program. The strengths of the "as found"—like thermal inertia and modularity of concrete elements—are fully used and complemented by a well-performing envelope of bio-ecological materials. This creates a "casco" where reversible layers can be added for specific uses. We focus on the process, not the final result. Conceiving the building as permanent limits flexibility and experimentation. Users are not assigned the role of consumers but rather that of producers. The resilient framework of the modular structure allows us to think in terms of building kits with standardized, compatible, and interchangeable components, assembled like a Meccano set. An open material bank is created, which is generic and scalable within the concept but can be tailored to specific applications. The goal is not only to standardize solutions through modularity but also to enhance reuse opportunities and reduce financial impact by maximizing compatibility. This approach fosters a dynamic, user-driven architecture—one that continuously reinvents itself in response to change and emerging challenges. The form follows the assembly method and the availability of materials. Like a *machine à habiter*, the renovation is viewed as part of a dynamic process of occupying materials and functions.

Keywords: Renovation, Reuse, Reversibility

Introduction

How do we approach buildings that are barely fifty years old but are in urgent need of renovation? And how can we reconcile seemingly conflicting demands, such as heritage value and energy efficiency or circular performance? Across Europe, similar questions have been addressed in the renovation of post-war modernist buildings, particularly in Dutch and Scandinavian projects, where circular design strategies such as minimal intervention, material reuse, and reversible construction are increasingly applied to balance preservation and performance. The former student housing on the VUB (Vrije Universiteit Brussel) campus in Elsene, designed by architect Willy Van Der Meeren in 1972, served as the ideal setting to explore the relationship between heritage preservation and modern requirements for sustainability, energy efficiency, and economic feasibility. The WVDM Living Lab bridges theory and practice in circular construction. For this project, MAKER, in collaboration with Origin, VK, VITO, and Beneens, conducted research into circular renovation strategies, which were then implemented in the pilot project. The project provides an in-depth, holistic analysis and demonstrates that the "as found" should not only be viewed as a legacy of the past, but also as an active contributor to the sustainable development of our society.

Context

Shortly after the founding of the VUB, against the backdrop of societal upheavals following the May '68 protests, Willy Van Der Meeren made a groundbreaking contribution to modern architecture with his design for student housing. The architectural expression of these buildings was directly related to their structural logic. Van Der Meeren used three-dimensional modules, prefabricated in concrete using the patented Variel construction system of Swiss architect and entrepreneur Fritz Stucky (Fig 1.b/2.a). [1] This system not only allowed for rapid construction and cost reduction, but also embodied Van Der Meeren's commitment to industrialization and modular building: it wasn't just about constructing functionally in an economically responsible way, but also about creating architectural added value. By freely connecting, stacking, and combining the prefabricated modules, Van Der Meeren created a dynamic whole that challenged the prevailing prejudices against prefabrication (Fig 1.a). He also used colour to provide additional visual distinction and an aesthetic identity. The structural details of the student housing demonstrate Van Der Meeren's mastery in building technology and materiality (Fig. 2.b). [2]


Fig. 1 (a) Student housing units at the campus of the VUB (Hilde Braet, circa 1990, Centre for Academic and Secular Archives (CAVA), VUB, Brussels); (b) Placement of the Variel-modules (photographer unknown, 1973, Archive Technical Service VUB, Brussels)

The more than three hundred modular student dormitories were once at risk of demolition. Today, they are being repurposed for a new, versatile use. The twelve modules involved in this pilot project not only serve as a catalyst for preservation but also pave the way for transitioning the remaining buildings to a circular renovation model. The WVDM Living

Lab is an initiative focused on co-creating sustainable renovation strategies, with respect for the value of the buildings and the ambition to preserve, recover, and reuse as many materials as possible.

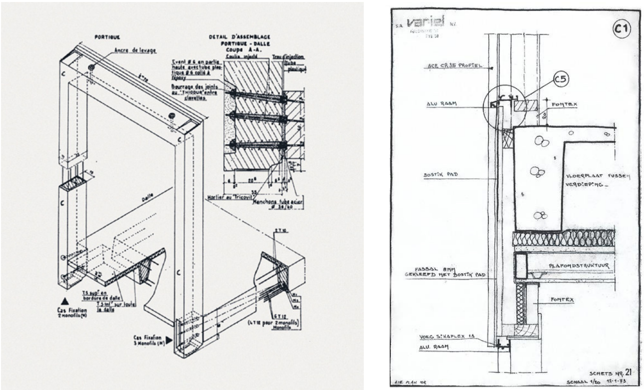

Fig. 2 (a) Axonometric drawing of the Variel structure (Jenatsch G.-M., Krucker B., 2006, Werk-Serie. Fritz Stucky: Architekt und Unternehmer, Zurich); (b) Detail of the facade (Willy Van Der Meeren, January 1973, Archive Technical Service VUB, Brussels)

Inspiration

The project starts with the question: What can we learn from post-war architecture in terms of circular building? In the rationality of post-war modern architecture, several principles of change-oriented building can be discerned, such as constructive honesty, skeletal structures, open plans, modularity, movable interior walls, and demountable (curtain) facades. In the renovation, the primary load-bearing structure, building volume, and urban footprint are preserved, while also maintaining the principles of prefabrication, modularity, and adaptable construction with minimal material use. The clear rhythmic composition of the facade is not only an important architectural element but also reflects the internal workings of the building. The aim is also to drive social progress through high-quality, progressive architecture.

The team identified six design principles that are not only characteristic of modernist thinking but also linked to Van Der Meeren's original design. [3] These are: 1) The building as *machine à habiter*, where functional and circular aspects take precedence over form, and the bare construction itself also serves as the finishing, 2) Modular standardization, 3) Adaptable construction, 4) The use of collective facilities based on social ambitions, particularly in outdoor spaces and roof areas, 5) The use of colour to animate the rational architecture and create a sense of place and orientation, and 6) The harmony between architecture and nature, e.g., by approaching water, energy, and materials in a holistic framework.

The study also highlighted scalability on the site itself. In addition to the twelve modules involved in the project, the student village consists of over three hundred other modules that are due for renovation. By extending the various infrastructures and flows (energy, mobility, social infrastructure, materials bank, green spaces, etc.) throughout the entire village, a truly urban ecosystem could be realized.

Strategies

The four developed renovation strategies differ in nature and offer circular solutions for specific challenges and conditions.
Tent (Fig 4.b): Questions the often-excessive material input in renovations. It emphasizes preserving the existing structure with minimal material use, a limited budget, and basic comfort. Achieving airtightness of the building envelope is central. This strategy does not require a building permit and primarily focuses on (transitional) renovations that aim for a minimal use of resources.
Cocoon (Fig 3.a/4a): Challenges the need for uniform comfort throughout the building. Instead, comfort is adjusted according to the space's use. A "cocoon" within the module provides high acoustic, thermal, and architectural performance. Technical installations are incorporated using a plug-and-play approach. Other spaces receive only basic comfort. Hotels, temporary accommodations, flexible programs, or different summer–winter uses represent potential programmatic uses for this strategy.
Layering (Fig 3.b): Focuses on a change-oriented buildup of the building envelope. The envelope is a complex assembly where components often have different lifecycles and maintenance needs. Techniques are integrated accordingly. This layered strategy considers adaptability, with inner layers designed for reversible modification to suit orientation, function, window openings, and technical systems. The strategy is suitable for programs with changing technical installations and finishes, such as offices and multipurpose spaces.
Fur: Aims for constant, continuous comfort. The entire structure is insulated, and thermal bridges are efficiently resolved. This strategy uses materials with minimal environmental impact, high-performance insulation, and passive techniques. The building's inertia allows for effective energy storage, providing thermal mass, absorbing heat during the day, and releasing it at night to stabilize indoor temperatures. This strategy is aimed at programs characterized by consistent and continuous use.
The strategies were elaborated through detailed design, implementation, and evaluation. The assessment was based on four key pillars: energy, heritage, sustainability, and economy. The lab believes that these aspects cannot be considered in isolation in a well-thought-out, innovative renovation project. Contrary to what is sometimes assumed, they are not

Fig. 3 (a) Cocoon strategy on the upper floor (Séverin Malaud); (b) Layering strategy on the ground floor (Séverin Malaud)

only compatible but can even strengthen one another. The lab's goal is to identify and demonstrate synergies between them. The focus on heritage is embodied in a design where "reversibility" is key: the proposed interventions are reversible, preserving the heritage and minimizing environmental impact through the future reuse of materials.
For each of the four proposed strategies, from "Tent" to "Fur", various solutions were developed that could be used in different living situations, from temporary living to adaptable lifelong housing. Housing is often combined with an additional function, such as office, studio, collective workspaces, or outdoor spaces like bike parking, covered terraces, or open-air classrooms. Ultimately, sixteen design scenarios were developed. Techniques were also concretely worked out, with special attention to passive strategies, responsiveness, adaptability, etc., in line with the basic principles of each renovation strategy. The scenarios show that the flexibility of Willy Van Der Meeren's modular student housing can be enhanced through interventions that not only address sustainability, but also the functionality of the building.

Fig. 4. (a) Cocoon strategy on the upper floor (Séverin Malaud); (b) Tent strategy on the ground floor (Séverin Malaud)

Spiderweb

To make an objective comparison, the strategies were carefully calculated and evaluated. In terms of energy, the focus was on the energy efficiency of technical installations, thermal performance of building components, and the adaptability and responsiveness of HVAC systems and controls. For heritage value, a qualitative assessment was made of the concept, materiality, visual quality, and collectivity. Regarding sustainability, material input, environmental impact, and adaptability were key factors. Finally, the economy was evaluated based on construction cost estimates, the "total cost of ownership" and space utilization (especially the thickness of wall assemblies). For each of these aspects, various tools were used, including EPB software, a specially designed framework for assessing heritage values, WBCSD Circular Transition Indicators (CTI), Disassemblability Index (LMI), and TOTEM (Tool to Optimize the Total Environmental Impact of Materials). The calculations for the four different strategies were plotted on a spiderweb diagram (Fig 5), allowing for a visual comparison of the strategies within one holistic perspective, and assessing them against the original goals.
Beyond the design-based and calculated evaluations, the Living Lab functions as a real-world testing ground in which the renovation strategies are subjected to everyday use. Long-

term monitoring of energy consumption, indoor comfort, material durability, and user appropriation is embedded in the project's framework, allowing feedback loops between design, use, and adaptation. This approach positions the project not as a finalized solution, but as an evolving system whose performance can be assessed and refined over time.

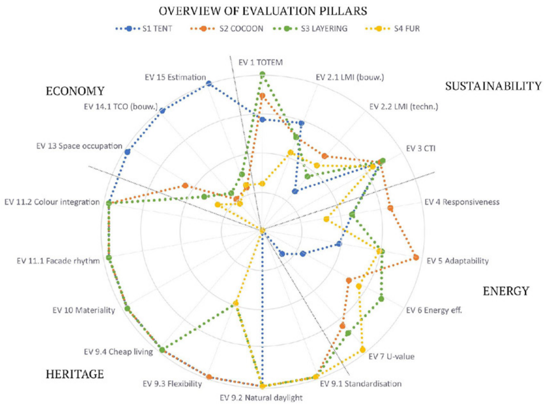

Fig. 5. Spider diagram showing evaluations by pillar and application of the strategies (MAKER architecten)

Scalability

Circular construction inherently requires tailored solutions—each project faces different constraints related to existing structures, the availability of reclaimed materials at a certain time and place, spatial and technical constraints in terms of reversibility, and client requirements. The four strategies were deliberately designed to be specific, ensuring the lowest possible environmental impact for each unique context. At the same time, the broader challenge was to develop scalable and replicable solutions without losing the project-specific adaptability that circular construction demands. Research was carried out into system-based approaches, prefabrication, and standardization. These efforts support the development of an open material bank—composed of interchangeable, reusable, and standardized components and detailing.

Three of the four strategies were ultimately implemented in the pilot project (Tent, Cocoon, and Layering) (Fig 6). While the strategies envisioned different construction details and use scenarios during the research phase, they were translated during the implementation phase into a shared and compatible building system that enables an evolutionary use over time.

We start with a "casco" that meets basic needs and comfort for any program. The strengths of the "as found"—such as its thermal inertia and the modularity of its concrete elements—are fully leveraged and enhanced with a well-performing envelope made of bio-ecological materials. This provides a flexible base onto which reversible layers can be added,

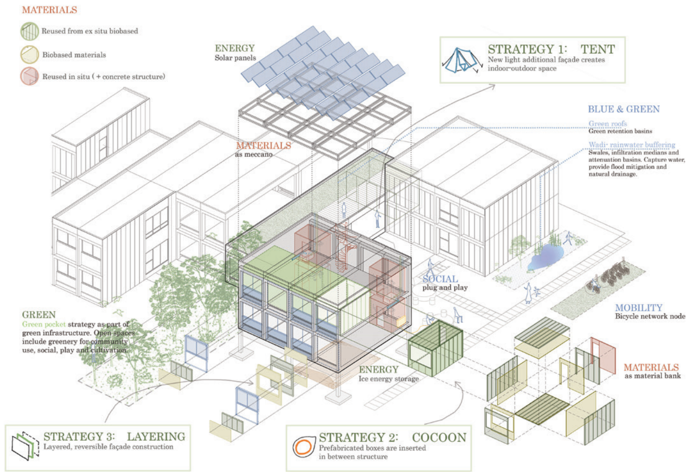

Fig. 6. Overview implementation of the strategies (MAKER architecten)

depending on specific use cases. Our focus lies on the process rather than a fixed end result. Conceiving the building as permanent limits flexibility and experimentation. Instead, the resilient framework of the modular structure allows us to work with standardized, compatible, and interchangeable components—assembled like a meccano set (Fig 7).

The open material bank is scalable and generic in concept but can be customized to suit different applications. The goal is not only to standardize solutions through modularity but also to enhance reuse opportunities and reduce financial impact by maximizing compatibility. This approach fosters a dynamic, user-driven architecture—one that continuously reinvents itself in response to change and emerging challenges.

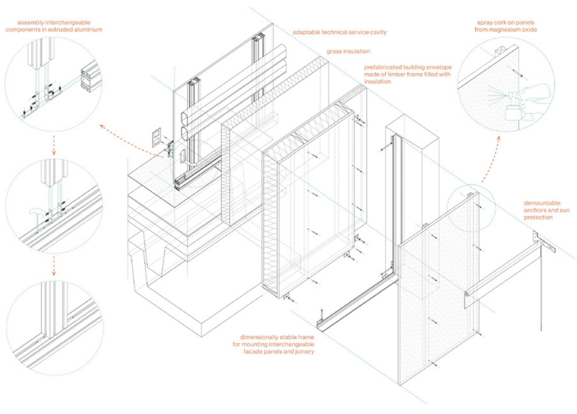

Fig. 7. Exploded axonometry of the facade layers (MAKER architecten)

Reuse

During the implementation phase, significant effort was made to reuse materials released during the renovation, such as the modular concrete structure, concrete sanitary units, terrace tiles, and pressed wood panels (Fontex panels). From ex situ projects, sanitary fixtures, lighting fixtures, insulation materials, carpet tiles, and kitchens were recovered (Fig 8). New materials were chosen for their bio-ecological properties, such as timber building envelopes, cork cladding, and grass-based insulation. The form follows the assembly method and the availability of materials. The final result reflects how components are reversibly assembled and the patina of reused materials. Like a *machine à habiter*, the renovation is part of an ongoing process of activating materials and functions—a living system in constant transformation.

Notes

1. Wouters, Ine, Stephanie Van de Voorde, and Emiel De Kooning. "3D Variel modules in precast concrete in Belgium (1969-1981). The work of Fritz Stucky and Willy Van Der Meeren." In *Proceedings of the Tenth International Conference on Structural Analysis of Historical Constructions*, 953–960, 2016.

2. Van de Voorde, Stephanie, Stephanie Elsen, Walid Galle, Ine Wouters, Linda De Groote, and Anne

Fig. 8. Reused materials: kitchen, lighting fixtures, Fontex panels, sanitary appliances, carpet tiles, insulation (MAKER architecten)

Castillo. "Erfgoed in transitie. Innovatieve renovatiestrategieën van het WVDM Living Lab." *Erfgoed Brussel* 38, 142-167, 2025.

3. See, among others, Van de Voorde, Stephanie, Ine Wouters, and Ina Bertels. *Post-war housing in Brussels: Student houses by Willy Van Der Meeren on the VUB campus in Elsene 1971-1973*. Brussel: Vrije Universiteit Brussel, 2016..

Bibliography

Stephanie Van de Voorde, Ine Wouters and Inge Bertels. *Post-War Housing in Brussels: Student homes by Willy Van Der Meeren on the VUB campus in Elsene 1971-1973*. Brussels: Vrije Universiteit Brussel, 2016.