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HARVESTING THE URBAN FOREST: A CASE STUDY OF THE CIRCULAR BUILDING SEMINAR AT UHASSELT IN BELGIUM

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ABSTRACT: The transition to a circular economy (CE) offers an alternative path to the current high-polluting and wasteful practices in construction. However, this transition will require a drastic shift from the way products and services are designed, produced, and used, also in the architecture and construction industry. This paper aims to contribute to the body of knowledge of novel methodologies to integrate CE into architectural design and wood construction education. This paper analyses the 2021-22 edition of the Circular Building Seminar at UHasselt in the Faculty of Architecture and Arts. In this study, we first provide a brief introduction to the course mission and its approach. Then we describe in-depth the 2021-22 winter semester assignment of urban harvesting and the role of wood in it. At the end, we evaluate and discuss the outcomes of the course, its relevance as well as possibilities for improvement in the next editions.

KEYWORDS: Wood Architecture, Timber Education, Circular Economy, Design for Circularity, Bio-based materials

1 INTRODUCTION

The construction sector is responsible for the largest individual share of greenhouse gas (GHG) emissions, accounting for 37% of all emissions [1], due to energy-intensive activities of material extraction, transportation, construction, and energy to operate buildings. Building construction activities alone represent 10% of all emissions [1]. Hence, the high emissions in the sector worsen the continuing heat up of the planet and contribute to the climate crisis. Moreover, the construction industry consumes 40% of the global resources [2] and is one of the leading producers of solid waste generated during the production of materials, construction, and demolition of buildings [3]. That means a large share of emission-intensive building materials produced from precious finite resources end up wasted in landfills at manufacturing, construction, or end-of-life.

The transition to a circular economy (CE) thus offers an alternative path to the current linear high-polluting and wasteful practices in construction [4]. The concept of CE is quickly gaining traction among both scholars and practitioners, indicated by its fast-growing number of peer-reviewed articles [5]. A CE is "restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times (...)" [6]. By decoupling wealth generation from resource consumption, a CE can simultaneously tackle many pressing challenges of our time, such as climate change, resource depletion, water, and energy scarcity [7]. However, a transition to a CE requires a drastic shift from the conventional way products and services are designed, produced, and used, including construction.

Previous studies emphasized the critical role of education in this transition [8], [9]. More specifically, higher education institutions can be strategic agents supporting a CE due to its dual impact of promoting behavioural change at the personal level and professional implementation in practice [10]. Hence, there is a growing interest in education for a Circular Economy (ECE) as educators from diverse fields start to develop educational approaches to incorporate a CE in their courses [8]. However, a recent literature review on ECE found institutions are still slow to adopt it as a fundamental part of the curriculum [11]. Specifically, in the field of architectural design, there is even less information addressing education from a CE perspective, with only a couple of published cases [12], [13]. Therefore, there is a significant knowledge gap regarding architectural design education in the context of circularity.

Ironically, among the several different fields of application of a CE, design sciences are of particular relevance. The literature on CE consistently identifies design as an enabling activity for the transition from a linear to a circular economy [4], [7], [14]. However, unlike the standard design process, designing for increased circularity requires more complex cognitive skills to approach the design problem from a lifecycle

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perspective. That means designers have an expanded work scope and must consider the design process from the origin of materials to multiple appropriate service spans and possible future uses [14].

To address the knowledge gap mentioned above, we must develop new methods to integrate design for circularity into the architectural design curriculum, so it also becomes an implicit part of the practice. This paper aims to contribute to the body of knowledge of novel methodologies to integrate CE into architectural design and education, and training of aspiring architects with new design skills required in the context of circularity.

2 MATERIALS AND METHODS

This study analyses the 2021-22 winter semester edition of the Circular Building Research Seminar at UHasselt in the Faculty of Architecture and Arts. The goal is to contribute to the discussion on education for sustainability and wood construction from the lens of circularity. It is worth noting that although wood was not the primary focus of the course, it consistently emerged as a critical topic in the discussion of circularity throughout the course. In this study, firstly, we provide a brief introduction to the mission of the Circular Building Research Seminar at its inception and its main approach. Then we describe in-depth the 2021-22 winter semester assignment of urban harvesting and the role wood construction had in it. Afterwards, we evaluate the outcomes of the course qualitatively. Finally, we discuss some strengths and weaknesses perceived as well as possibilities for improvement in the next editions.

3 RESULTS

3.1 THE CIRCULAR BUILDING RESEARCH SEMINAR

The Circular Building Research Seminar is a 2-semester course for students in the master program, offered at UHasselt, Faculty of Architecture and Arts, every year since 2017. Originally the semester assignment alternated between an experiment-based and a reality check one. In the former, students were challenged to develop out-of-the-box thinking when considering the design and build assignment, whereas in the latter, students started from standard or established materials and processes in the built environment with the goal to pursue circular innovation. It is worth noting that over the years the relationship between both semesters has become more blurred.

From an educational standpoint, the course aims to uncover the possibilities for circular thinking in architectural design, thus providing an opportunity for students to explore new ways to transform buildings from a liability in terms of environmental impact to positive generators of biodiversity, energy and material resources. The instructional approach consists of a combination of research-based and design exercises. Moreover, at the Circular Building Research Seminar, theory and data operate as the foundation to master circular thinking and action to create innovation. This is further supported by reading assignments and discussion sessions on multifaceted topics that go beyond the mere theme of circularity in the construction sector. The goal is to familiarize students with the wider societal and economic context that is driving the need for more sustainable resource use.

The learning outcomes intended are triple-fold. 1) To contribute to the relatively novel and unexplored theme of circular construction with regenerative materials to inspire colleagues and decision-makers. 2) To stimulate students to engage with circular thinking to become better designers and builders. 3) To provide an opportunity for students to engage with scholarly research as an essential part of the design process.

Over the years, the course experimented with a variety of topics to pursue its goals, namely Circular Building Renovation (2017-18), Circular Building Systems for Cavity Walls (2018-19), use of Regenerative Materials (2019-20), and Prefabricated Building Concepts with Regenerative Materials (2020-21). The 2021-22 run of the Circular Building Research Seminar proposed the topic of Urban Harvesting as a means to advance the discussion of circularity in design and education. Every edition aims at incorporating hands-on experimenting through design-build assignments, as well as conceptual reflections on circularity under the existing frameworks.

In the 2017-18 edition on Circular Building Renovation, students first got familiar with the concept of circularity by exploring the RESOLVE framework [15] (Ellen McArthur Foundation) through different case studies, and then developed six circular renovation scenarios for their main faculty building - a concrete building from the 80s designed according to the principles of Herzberger, perceived as highly flexible, but actually quite rigid. Each scenario started from a perceived challenging issue, such as better water management, making the building fit for a broader use, and using the building as a display for regenerative materials. In the 2018-19 edition, students assembled and disassembled 3 walls (3x3m each) with market-available circular building systems for cavity walls, and evaluated their circular performance with the circularity framework developed by Vandenbroucke [16], also proposing improvements for specific aspects [17] (Figure 1). In the 2019-20 edition, students took part in a 1-day hands-on workshop on 4 bio-regenerative materials (mycelium, willow, earth, lime hemp), and then explored the opportunities of these materials through hands-on experiments (Figure 1). This resulted in the design and execution of a wide range of objects, later exhibited at the construction fair Batibouw 2020 as part of the stand of two organizations promoting sustainable construction. The stand itself was also fully circular and developed by the students and their teachers in collaboration with the organizations. In the 2020-21 students were tasked to rethink and redesign an existing tiny living unit with the

goal to make it fully circular and bio-based. Because of COVID 19, no hands-on activities or experiments were possible in this edition, so the outcome was limited to architectural sketches, drawings, and 3d modelling.

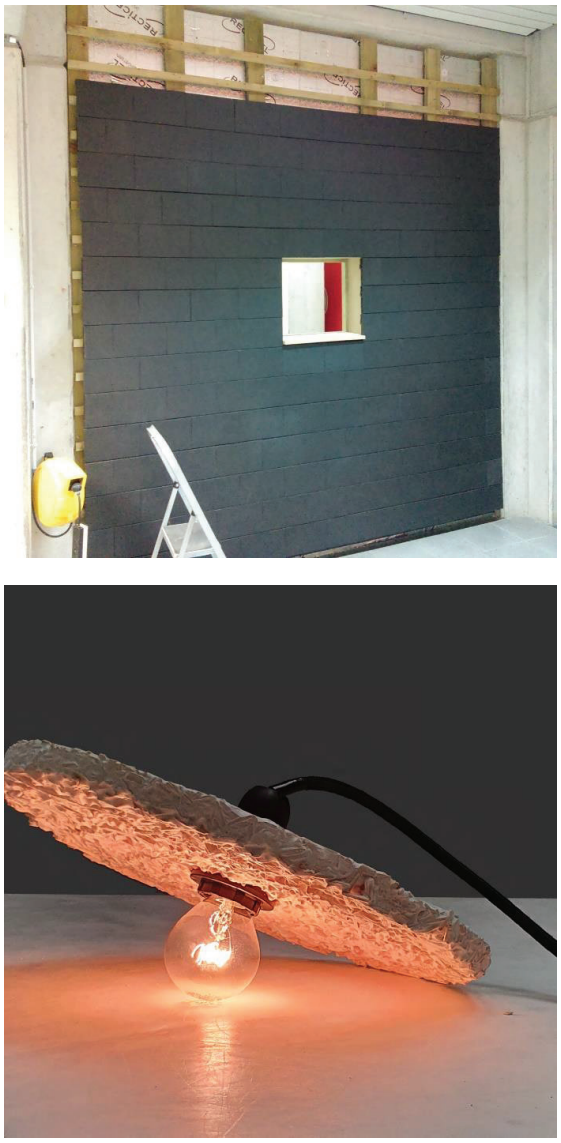

Figure 1: *Outcomes of editions 2018-19 (top) and 2019-20 (bottom) of the Circular Building Research Seminar.*

3.2 THE 2021-22 EDITION OF THE CIRCULAR BUILDING RESEARCH SEMINAR

The 2021-22 edition builds back on the repertoire developed in the previous editions of the Circular Building Research Seminar and tackles the theme of Urban Harvesting, understood as the possibility to leverage existing, readily available material flows in the environment that are currently perceived as waste. The idea opposes the conservative approach of extracting and processing virgin materials, that even if sustainably designed, can contribute up to some extent to resource depletion and environmental impact.

To explore the theme, the course instructors provided a list to the students with four distinct geographic regions to choose from: the municipality of Genk, the city of Hasselt, Hoge Kempen National Park, and UHasselt Campus in Diepenbeek. Each option presented a different context with a fresh batch of challenges to solve, ranging from more consolidated urban areas to a natural reserve. The course flowed through three main phases as follows.

Phase 1: The 2021-22 edition started with an Urban Harvesting workshop. Here lecturers introduced critical concepts of material and energy flows of and in our built environment. The goal is for the students to grasp the challenges and possibilities of combining flows to pursue added value.

Phase 2: Next, the participants mapped, documented, and visualized local flows of raw materials from the surroundings of their chosen areas. (Figure 2) The idea was to brainstorm a diverse range of applications and products based on the mapped resources and flows. For the brainstorm, the positive impact workshop was used, as developed in the Erasmus+ KA Active8 Planet project [18]. In this workshop, four lenses are used to reflect on the opportunities to create positive impact with the local material flows: a local social lens to reflect on the positive impact that can be created locally on social aspects such as jobs, income, community, etc, a local ecological lens to reflect on the positive impact that can be created locally on ecological aspects such as water management, biodiversity, etc. and, likewise, a global social lens and a global ecological lens that induces a reflection on how decisions made locally can have a positive impact globally [19].

Phase 3: The final phase consists of a design exercise in response to the findings from Phase 2. In other words, the design solutions had to answer a realistic challenge or need as detected during the mapping. This phase also encourages a hands-on verification of the design propositions feasibility through prototyping and scale models.

3.3 SCALES OF INTERVENTION AND USE OF WOOD

Students organized themselves into four groups (one per region), with eight participants each on average. Based on the results from the mapping exercise and positive impact brainstorm of Phase 2, students decided the focus of their design proposals between four scales of intervention, namely urban, building, element, and material scale.

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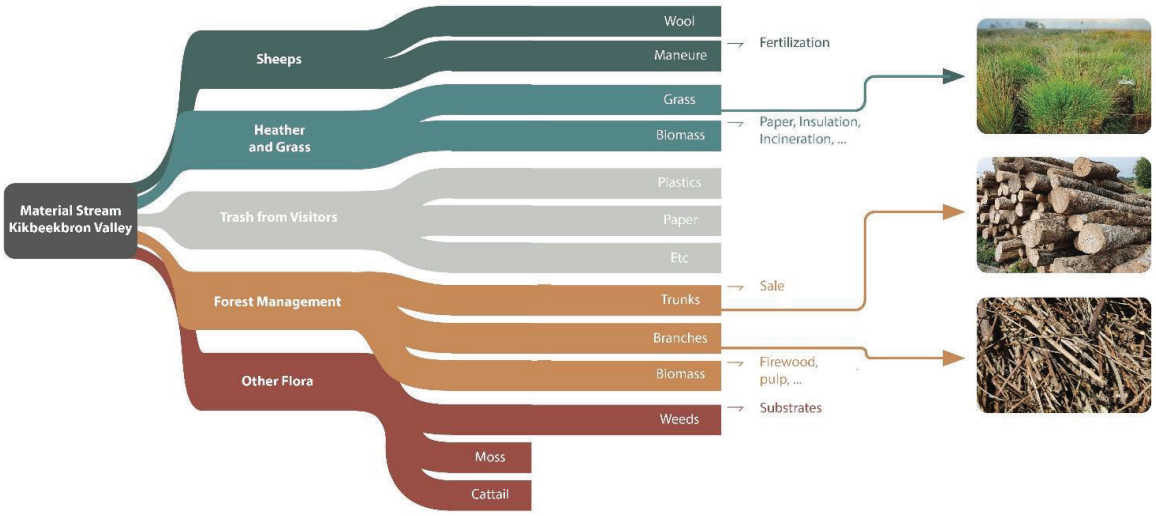

Figure 2: *Material Flow Map of National Park Group*

The UHasselt Campus group focused on the urban scale. In this scale, the challenge was to look for synergies with what is already consolidated and optimize the resource flows to foresee efficient, future-proof land uses. Furthermore, the group linked their research to a real-life ongoing project on the campus related to some perceived mobility issues, such as the limited use of bikes and public transport, and excess of private car use by students and staff, which results in a lack of parking space and plans to build a large allegedly circular parking building. In response to that, the group proposed and developed a multi-modal transportation master plan for the campus, employing locally harvested wood species as engineered wood-based products for the construction of the transportation facilities on campus.

The National Park group focused on the building scale. In this scale, it was critical to couple the development of a given building with its surroundings as to create a virtuous circle during its whole lifecycle. The group looked into ways to use logs obtained from thinning and pruning of forests in the park as the structure for small off-grid holiday units (Figure 3). Their design was a critical reflection and a counter-proposal to a new development of allegedly sustainable, high-end, luxurious holiday units in the National Park.

The city of Hasselt group focused on the element scale. In this scale, versatility, durability, and reuse were key criteria to guarantee an extended lifespan of the materials harvested and used. The group proposed to employ prefabricated panels using reclaimed wood from the demolition of blighted houses for repurposing vacant commercial buildings into temporary student rooms, in response to a real need for extra student rooms offer, due to a growing number of students at UHasselt and nearby university colleges (PXL and UCLL). (Figure 4)

The Genk City group focused on the material scale. In this scale, the investigation of potential materials and methods that prevent further depletion of resources had a prominent role. The group aimed to design affordable DIY furniture kits, reusing wood from discarded pallets from the port. (Figure 5)

Figure 3: *Scale Model of proposed off-grid holiday units*

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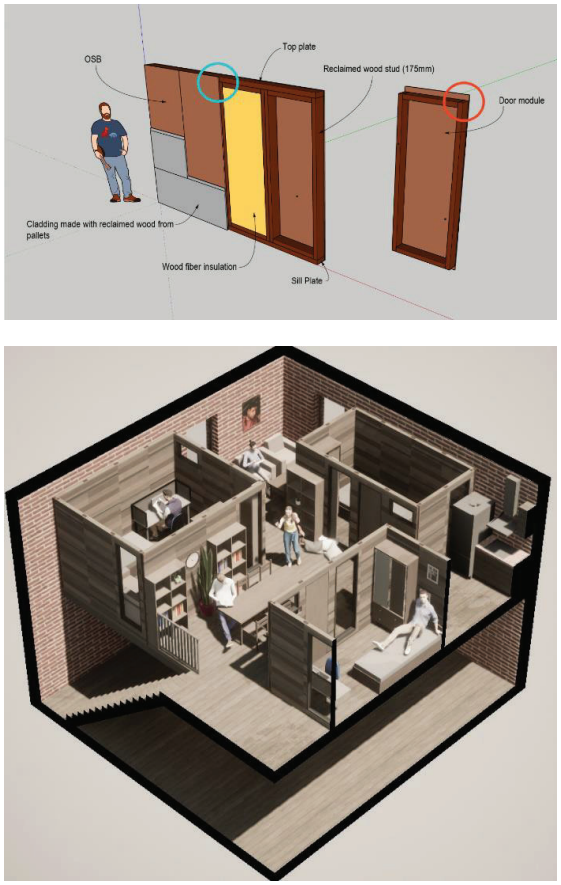

Figure 4: *Visualization of prefabricated panels(top) and retrofit proposal of a vacant commercial building (bottom)*

4 DISCUSSION

Even though the Circular building Research Seminar was not focused on wood construction, the search for materials to harvest in both urban and natural settings, as well as less impactful design solutions led all groups to investigate at least one possible way to utilize wood. In most cases, the information gathered during Phases 1 and 2 pointed to wood as a potential answer for a regenerative and low-impact design. That endorses the critical role that wood as a building material now plays in the broad topic of education for sustainability and design from the lens of circularity. Hence, to generate change through education, it seems relevant that curricula from schools of architecture actively find ways to provide the opportunity for students to engage with the material in both focused and unfocused disciplines.

Furthermore, the Circular Building Research Seminar intended to introduce a new mindset to students related to tackling design problems and finding solutions. More specifically, the seminar works backwards compared to a "traditional" design studio approach. Conventionally, students start pursuing formal and functional aspects by developing a holistic design concept. Then, students confront the feasibility of their design concepts in terms of materiality, dimensions, and technical performance. The result of this reality check is the design solution. In the Circular Building Research Seminar, students first face a tangible context to understand and interact with, which provides them with only a limited set of resources in terms of materiality, performance, and technology. From the available resources, students must then conceive innovative design solutions that meet a specific need. In this case, the final result is a holistic design concept or approach as an answer to the possibilities and limitations offered by the context.

Figure 5: *Mock-up of DIY chair using reclaimed wood from pallets*

Likewise, the course also proposes a more scientific approach to the design process, in which theory and data must guide design decisions. Because the course challenges the participants with a fresh new design approach, most likely for the first time in their education, mindset adjustments and new skills development are needed. That, of course, requires time and effort on the part of the participants and instructors. We understand it as a positive part of the learning process and growth of the students as designers, also supporting the expected learning outcomes 2 and 3 (item 3.1). However, the relatively large volume of new information and skills needed also partly hinders the depth of the explorations.

Particularly in the 2021-22 edition of the seminar, it was noticeably difficult to gather the necessary information on material flows, attesting to the still lack of such valuable information publicly available or with enough detail. Additionally, the ambitious goal to achieve innovative

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circular design solutions in the period of a single semester (15 weeks) can be hindered by an overall lack of previous experience with basic woodwork skills by the students, leading to a lack of depth and quality of the outcomes both from an aesthetic and circular point of view, such as in the Genk City group.

5 CONCLUSIONS

This paper presented the Circular Building Research Seminar in the Faculty of Architecture & Arts at UHasselt and described its 2021-22 edition in detail. The chosen topic of urban harvesting yielded a diverse scope of design approaches, ranging from the urban to the object scale. In the view of the instructors, it successfully introduced to the students a flipped way of thinking about the design process, developing a holistic design concept from the availability of given resources instead of assigning materiality to a pre-defined design concept. Furthermore, even though wood-based materials were not the particular focus of the course, they had a distinctive role in all four projects, attesting to the relevance of including wood-based design and construction-oriented courses in the traditional curriculum of architecture schools. On the other hand, the overall quality of design solutions was below expectations, partially due to the combination of a lack of primary information on waste flows and unfamiliarity with basic fabrication and construction techniques. It is also noteworthy that the ongoing corona crisis at that time, hindered the possibility of more hands-on activities. Regardless, the two groups that actively integrated physical modelling and prototyping in their workflow achieved slightly better results. That also attests to the relevance of introducing hands-on activities as part of the learning process in balance with more traditional theoretical activities. By sharing and evaluating the experience in the Circular Building Research Seminar, this paper aimed to contribute to the body of knowledge of novel methodologies to integrate CE into architectural design and wood construction education.

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