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Architecture of the Found

Broadening the Perspective of Adaptive Reuse from Buildings to Materials

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Abstract

While adaptive reuse, which has come into focus in recent years, has always been a self-evident part of the toolkit of architectural design, the reuse of materials is more typical of spontaneous or vernacular architecture, and is not a common part of the mainstream of architectural design. However, the basic idea of reusing spaces and building materials is the same: preserving and activating existing values, thereby reducing emissions and avoiding waste. Three advantages at once. We propose to broaden the established concept of adaptive reuse by making the reuse of materials a part of it, further opening the discourse towards environmentally conscious and circular design principles. While in classic adaptive reuse materials are used on site, within the building, the current task of architecture, to drastically reduce emissions and function within planetary boundaries, requires a broader approach of reuse. Not all buildings can be saved and in current practice their materials are lost forever. We compare realized architectural projects that focus on designing with reused building materials, both by international practices and student projects that were part of a design course initiated by the authors. We are focusing on architectural strategies and dive into ways and levels of reuse. We highlight the differences and similarities of the design process and the end results comparing them with traditional building projects. We argue that reusing building materials can enrich the final design of buildings by adding an extra layer of meaning to them while making sure that building doesn't put an unwanted burden on the environment. Architects should use the opportunities of material reuse and foster second hand material availability by putting a demand on it. Adaptive reuse should use its momentum and open toward adaptive material reuse, because successfully realized projects can pave the way to environmentally conscious architectures.

Keywords: Urban Mining, Material Reuse, Embedded Value

From Adaptive Building Reuse to Adaptive Material Reuse

Buildings that are currently designed are putting a lot of pressure on the environment. According to the Paris Climate Agreement (United Nations 2015), we need to reduce the carbon dioxide emissions of materials used for buildings by around 80% to keep global warming under 1.5-2 degrees. This is an immense task and we have very little time for it.

The next 5 years are crucial and it can only be achieved by combining different strategies than can be utilised to reduce consumption of energy and materials: designing smaller and adaptable buildings, using renewable and biobased materials, adaptive reuse of the existing building stock and material reuse.
Adaptive reuse is a concept that has gained real traction in the last years, but it was always part of architecture. Whereas the reuse of second-hand material was more a necessity and sometimes an opportunity throughout architecture history, more common in spontaneous and vernacular architecture and did not become part of the canon of architecture. Nevertheless the reuse of spaces and that of materials is built on the same idea: value conservation: cultural, social, financial, environmental value (Fagnoni 2016, 39-45). In this article we focus on the environmental value that lies in reducing emissions and avoiding waste. Adaptive reuse offers one of the most effective ways to design within the boundaries of the above mentioned Paris agreement. Simply by keeping parts of a building, we avoid a big part of the emissions because the embedded emissions of building materials could be much higher than the in-use emissions in the case of energy efficient buildings (T. Ibn-Mohammed et al. 2013, 232-245). Let us look at our buildings according to the Shearing layer model of Steward Brand (Brand 1995, 38-39): in adaptive reuse, most commonly, two layers the Structure and the Skin of the building are kept, with small alterations, these have also the highest embedded carbon footprint. Frequently, Spaceplan, Services and Stuff are the layers that are removed, since they are not serving the purposes of the new use leading to material loss and downcycling.
Adaptive reuse of buildings is not always possible or feasible, which most commonly means that the complete building and all its layers get demolished and with it the cultural, environmental and financial value gets lost. To avoid this, we want to open the concept of adaptive reuse to the reuse of materials. By reusing the building materials, the same values can be saved and with it the environmental damage avoided. The reuse of materials is not a replacement of adaptive reuse but a supplementary step to reach a truly circular and low-impact design practice, in case disassembly (previously called demolition) cannot be avoided. The time of endless materials is over, buildings can and should be realized with pre-used building materials. We should look at buildings as material storages, new and existing alike. The act of building should move towards assembling and disassembling materials. This shift is driven by rising raw material prices and the gradual depletion of resources. The European Union's push toward a circular economy has prompted decisive action across Europe. Demolition companies are increasingly shifting toward recycling and reuse, while material reuse is now included in some architectural and construction tenders. The transition is further supported by innovative clients and designers, with several completed projects demonstrating its potential.

Reuse of Materials in Theory and Practice

The Explorative Architecture Department at the Faculty of Architecture at the BME (Budapest University of Technology and Economics) took an effort in introducing the above-mentioned challenges into the curriculum by assigning their students to work on design projects that go beyond functional design tasks.
The architecture program at the BME is dual in nature: design and technical subjects are taught in parallel. The main design subject in the third year is entitled Architecture of

Workplaces 2. Every year, approximately 220-240 students enroll in the course, during the teamwork phase, more than a hundred different projects are completed based on the same assignment. As a result, there are a sufficient number of plans to analyse different design theory methods on them. In 2023 and 2024 the third-year architecture students became familiar with the challenges of designing with reused materials within the framework of the course. We adapted a real assignment to fit the scale of the semester: the students had to design a circular pavilion building for the Utrecht University campus, which would also serve as the entrance building to the botanical garden. It was mandatory to use reclaimed materials from a donor building scheduled for demolition on the Utrecht campus. The university itself organized a competition in 2024 for the design and construction of one of their new buildings and the reuse of the same donor building was part of the scope. More than a 100 different designs were created during the course proving, that strong frameworks like reusing materials do not limit artistic freedom. In fact, the theme also incorporated other sustainability ideas that go beyond the reuse of building materials: for example minimum space requirements, seasonal use, minimum comfort requirements.
The semester ended with an exhibition showcasing a selection of the projects. Our focus was on identifying recurring patterns and methods across multiple projects—elements that could later be applied more mindfully in future works. We evaluated the designs using the 10R method (Cramer 2017, 14-21). To fit the project we reduced the ten levels to eight. The lowest level of Recover is not applicable and we combined the levels of Repair and Remanufacture as one category. In our classification the highest level is Refuse, avoiding material use, while the lowest is Recycling. We also wanted to compare the design strategies of the students with that of real-life projects. The 10R method served as a great way to categorize both student work and the already realized work of architects. Below follow the 10R categories, first with a realized project and then the characteristics of selected student projects.
REFUSE, minimizing new construction by using the existing building stock
Bluecity Office | Superuse Studio | Rotterdam | Netherlands | 2017
Superuse Studio, together with other circular companies, took over the abandoned former Tropicana swimming pool and disco in Rotterdam, saved the building and its materials from demolition and transformed it step by step. (Superuse studio 2017)
The students of the Workplaces 2 course that followed the REFUSE approach designed a new building while keeping and complementing the existing building on site, accepting its aesthetic and spatial characteristics. The most common result was a composition of the old building and new (mostly reused) elements.
REDUCE, avoiding (space) usage by using less, more economical spaces
PIT Lab | DOOR Architecten | Amsterdam | Netherlands | 2018
DOOR architecten own temporary office building, designed for 10 years, is a first and eternal attempt at designing from second-hand materials. In the building, which uses shipping containers as a frame, the young office always occupies just the space it needs. As the company grows, the occupied and temperature controlled space grows with it. (DOOR architecten 2018)
The students aimed to create only the minimum necessary interior spaces. They combined compact volumes for function that require temperature controlled conditions with open air function and thus minimized the total material use. Overlapping uses and making adaptable


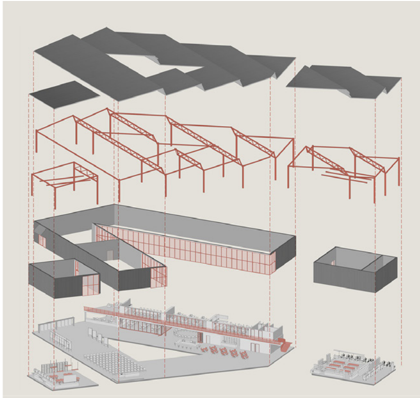

Fig. 1. Student project from REFUSE category by Tibor Megyeri & Anna Mezei

spaces also fell into this strategy.

RETHINK, rethinking traditional design along circular design principles

LOT8 | BC architects & studies | Assemble | Arles | France | 2023

The French architects transformed the existing building using local, natural materials. Their aim is to showcase and promote the knowledge, craftsmanship and technologies associated with local, natural materials. (BC architects&studies 2023)

This strategy is characterized by student projects that experimented with alternative materials, such as natural materials like thatch, rammed earth bricks, wooden panels. Others designed the building to be demountable with a possible next life cycle in mind.

REUSE, one-on-one reuse

Biopartner 5 | PTSA | Leiden | Netherlands | 2021

The work by Popmar Ter Steege Architects is one of the first buildings in the Netherlands to be built with a donor structure. This means that the entire steel-concrete structure was


Fig. 2. Student project from REDUCE category by Réka Keszei & Boglárka Szarka

transferred from another building to the university laboratory building. (PTSA 2021)
The student projects in this strategy worked with the relocation and reuse of the complete halls of the donor building. The positioning and integration of a complete building into a

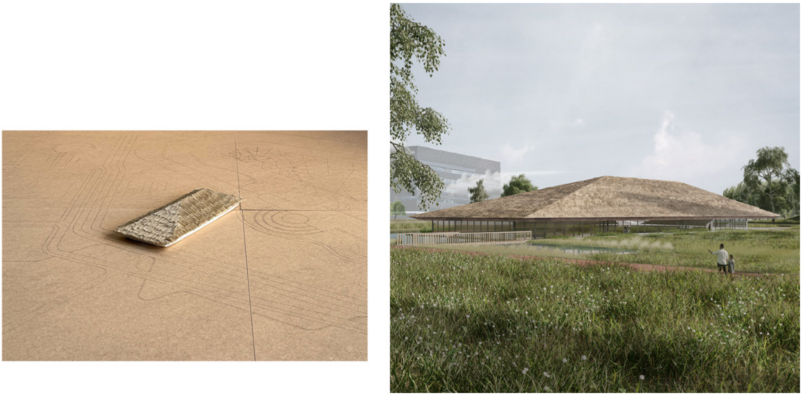

Fig. 3. Student project from RETHINK category by Tas Szabó & Viktor Rideg

new ensemble was what made these projects particularly interesting.
REPAIR & REMANUFACTURE, repairing and remanufacturing existing building elements in situ or after dismantling, with the aim of reuse and extending their lifespan
K118 | baubüro in situ | Winterthur | Switzerland | 2021
The Swiss building could be a classic example of adaptive reuse and expansion, but the addition ('repair') of the industrial building is made entirely of reused building elements, based on the aesthetics of found materials. (baubüro in situ 2021)
The student projects focused on the reuse of existing building elements with no alterations in their new designs. This led to very characteristic solutions in which the reused elements became centerpieces of the new buildings.
REFURBISH, reuse of elements with the same function, but from smaller elements
Circular pavilion | DOOR architecten | Utrecht | Netherlands | 2024

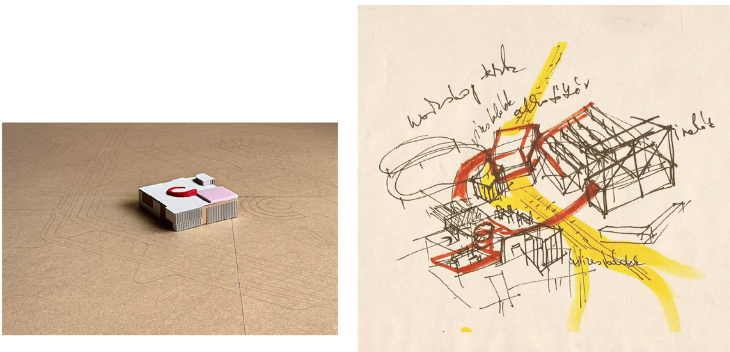

Fig. 4. Student project from REUSE category by Rebeka Barócsi & Lívia Komjáti

DOOR architecten received the same brief as the Workplace Architecture 2 students: to design a building entirely from the materials of a donor building. Functional schemes were aligned with spaces defined by the donor's supporting structure to maximize reuse with minimal modification.
In the student projects, a similar strategy was used, but with a key difference: the existing building was broken down into smaller elements and its structural components treated as building blocks. These were recomposed additively to form a new building. This approach proved the most popular, as it enables extensive material reuse while offering greater design freedom. The projects demonstrate how new combinations of existing materials can

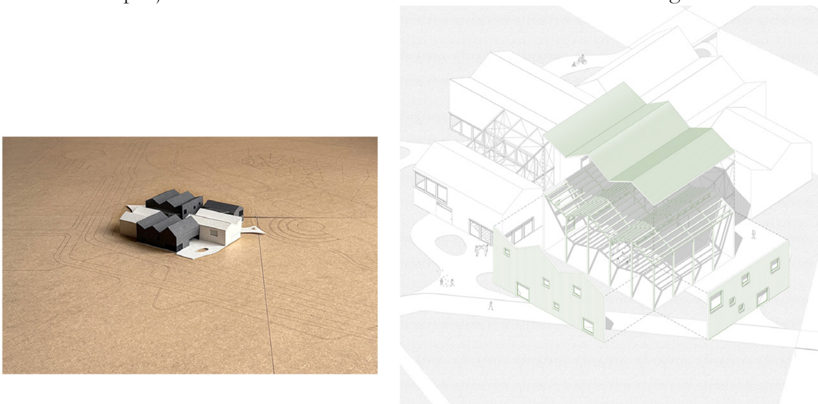

Fig. 5. Student project from REMANUFACTURE category by Benedek Paksi & Dániel Sebő

produce architectural outcomes very different from the original donor building.
REPURPOSE, reuse, but with a new function
Thoravej 29 | Soren Pihlmann | Copenhagen | Denmark | 2025
The most spectacular element of the Danish project, the staircase created from cut-out floorboards, is a perfect example of how reuse can speak a new architectural language that will convince even the most determinedly resistant architects. (Pihlmann 2025)
This strategy is based on dismantling and reassembling, using existing building elements freely to create a completely new building. The elements undergo a major transformation, fulfilling a new function in the new building: trusses become railings, floor elements turn into facade elements.
RECYCLE, recycling existing material as a new raw material
Upcycle Studios | Lendager Group | Copenhagen | Denmark | 2019
Lendager Architects is at the forefront of circular architecture, and this residential building was built with recycled concrete, repurposed windows, and wood cladding. It was completed with 45% less carbon dioxide emissions than a traditional building. (Lendanger Group 2019)
Maybe the most obvious strategy that gave the students the most freedom, nevertheless they used this consciously in their designs and found the best use of the recycled materials within their projects.

(Re)gained Conclusions

The main goal of the university project was to familiarize students with the challenges of designing within planetary boundaries by designing with existing materials. We encountered a lot of creativity but also struggles from the students and even their teachers, who had to be the guides in a challenge that was also new for them. The analysis of the final projects, the buildings and the conversations with students and teachers lead us to draw below conclusions.

Similarities of Adaptive Reuse of Buildings and Materials

All of the above mentioned projects require a different kind of creativity than designing with new materials. Designing with existing structures, spaces, or materials introduces greater constraints, making careful analysis and engagement with existing conditions essential. Designers must embrace material and spatial qualities, often highlighting imperfections as aesthetic features. Unexpected material combinations, non-standard detailing, and new functions for familiar elements are common, with standard requirements translated into unconventional spaces. Finally, the visible history of reused materials adds meaning, expressing the designers' relationship to the past and their conscious approach to sustainability.

Differences between Adaptive Reuse of Materials and Buildings

While the previously mentioned similarities are more evident, there are also important differences in designing with reused building materials. In both cases, analysis of the existing is essential; however, adaptive reuse focuses on space and structure, whereas material reuse emphasizes materials and their properties. Demountability is crucial for material "mining," as age, lifespan, size, adaptability, and structural qualities all affect future reuse. Unlike traditional projects, where such properties are known from suppliers and considered later, these factors must be addressed from the outset. As a result, material availability and storage become major challenges, requiring new actors in the building process. Finally, architects and clients must accept greater uncertainty, as limited availability and demountability introduce risks and make fully predictable outcomes unlikely.

Embracing Material Reuse

Our shared responsibility towards a liveable planet for future generations convinced us years ago to focus our field of research into working towards architecture within the planetary boundaries. Architects embracing adaptive reuse projects are on the frontlines of this work. We are convinced that they are the ones that can be encouraged to also embrace the reuse of materials as the next best option, after adaptive reuse. There is a vast richness to explore within this field and the added environmental gains are more than convincing.

Notes

1. The HouseEurope! initiative calls for the introduction of incentives to make the renovation and retrofitting of existing buildings a standard and best practice across Europe. https://www.houseeurope.eu/ (Accessed October 30, 2025.)

2. OPALIS (EU) https://opalis.eu/en - online map with dealers, products, sample projects

ROTOR DC (BE) https://rotordc.com/shop - trade in reused building materials

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