An Intergenerational Shift in Mindset

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Abstract

The conservation, maintenance, and repair of the built environment have recently taken center stage in architectural discourse. This shift is driven by the urgent need to operate within planetary boundaries and to adopt sustainable approaches – not only environmentally, but also socially and economically. Concepts like circularity and reuse offer alternatives. However, a significant transformation in practice – moving away from demolition and replacement toward preserving existing structures – has yet to materialize fully. While market dynamics in construction and real estate are often cited as barriers, a more profound transformation may lie in rethinking how architecture and related disciplines are taught. A shift in the didactic and pedagogical approaches to teaching architecture and related subjects, even at an early school level, could effectively enable this urgent transition. Can we cultivate a generation of sustainable natives who value what has already been built, while also challenging established building practices by integrating novel methods and technologies across generations and disciplines? This paradigm shift calls for interdisciplinary, innovative teaching methods and knowledge frameworks. Recent teaching, research, and outreach initiatives – along with publications focused on repair and maintenance – are beginning to lay the groundwork. These efforts aim to develop scalable strategies that address a wide range of challenges facing our built environment.

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Received:
16 December 2024

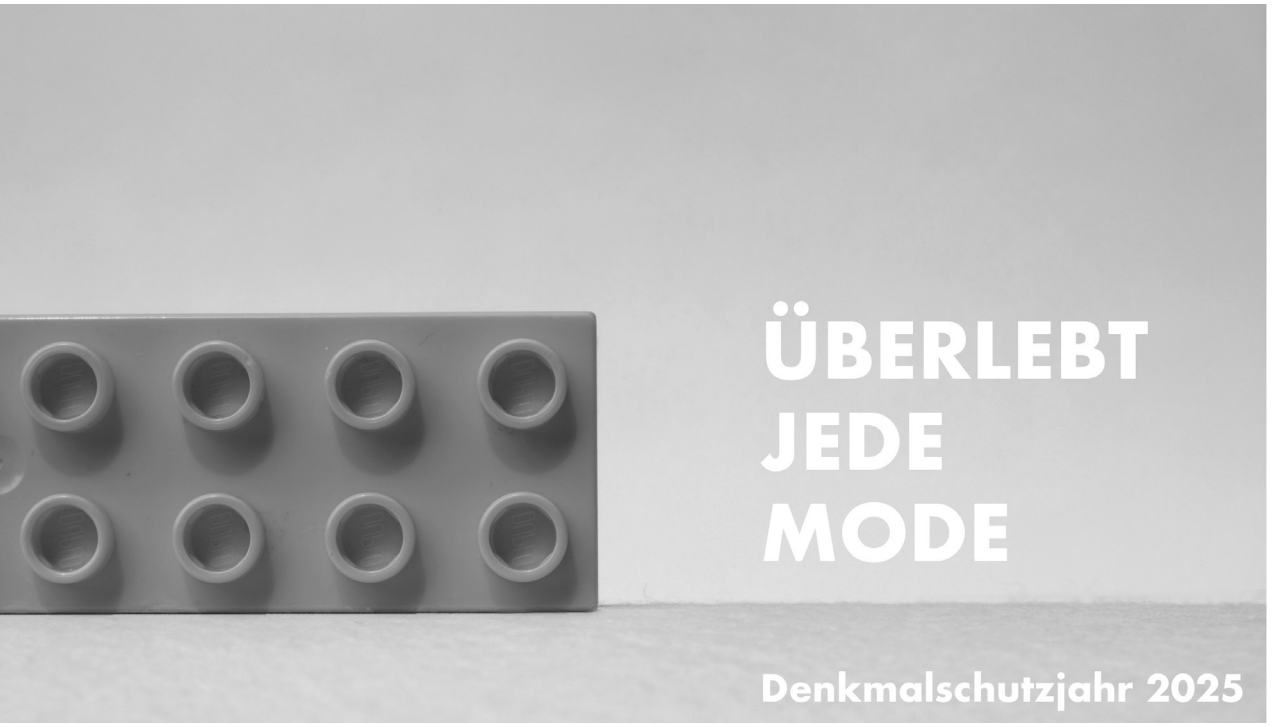
Accepted:
5 September 2025

DOI:
10.17454/ARDETH15.09

ARDETH #15

Introduction

The need to conserve, maintain, and repair our built environment has become increasingly central to architectural discourse. This conversation now extends well beyond the traditional realm of monument preservation, where it has long been a core concern. Today, the focus is shifting toward building *in* and *with* the existing fabric of our cities, driven by the urgent imperative to operate within planetary boundaries. This is not a new idea. Scientists and activists have been advocating for a more responsible and sustainable approach to the built environment for decades. As early as the late 1990s, concepts such as embodied energy and material flows began to appear in architectural education (Kastner, Langenberg, 2023). In the field of monument preservation, foundational works – initially published almost exclusively in German – laid the groundwork for a broader evaluation of historical buildings, incorporating considerations of resource use and embodied energy (Hassler, Kohler, 2011). Despite this growing awareness, the building industry has yet to undergo meaningful change. There is a broad consensus that architecture and construction



must fundamentally rethink their relationship with existing structures. Rather than defaulting to demolition and new construction, the priority must shift toward maintenance and repair.
However, when it comes to implementing effective measures, the conversation often narrows to economic instruments like carbon taxes or regulatory frameworks. What's needed is a deeper shift in mindset – one that also applies to the field of monument preservation. To fulfill its mission, the discipline must broaden its scope and collaborate more closely with architects, engineers, and industry professionals.
What is often missing from the current discourse is the recognition that a fundamental shift in mindset is needed – especially among younger generations, including architects and all those who shape our building culture. This could correspond to cultivating a new generation that begins its practice from a foundation of preservation, maintenance, and sufficiency (Fig. 1). Just as we speak of *digital natives* – individuals who intuitively understand and engage with digital technologies – we could also foster the emergence of *sustainable natives*. These would be professionals who

Fig. 1 - "Survives Every Change in Fashion," student campaign. The message is that there is plenty of good design, and acknowledging and preserving it is key to creating a sustainable building culture. Student project by Milena Bovet, Leonie Fest, Ansgar Keller, Anna Ludwig, Ansgar Stadler, 2021. Credit: Professorship for Construction Heritage and Preservation, ETH Zurich.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inherently value and prioritize sustainability in their approach to the built environment.
To achieve this, we must explore new didactic and pedagogical strategies. What kinds of educational frameworks and teaching methods would support this transformation? Could the integration of monument preservation with architecture, design, engineering, materials science, and the social sciences play a pivotal role in shaping this mindset?

A bottom-up approach for systemic change
In their introduction to the ARCH+ issue *The Great Repair*, the editors observe that "[...] the revolutionary ambition of radical systemic change, a hallmark of grand solutions, collides with the evolutionary act of repair" (Hertweck et. al, 2023). This "evolutionary" nature of repair – especially as a didactic concept – has gained momentum not only in architectural and design education but also across various disciplines. For decades, initiatives like DIY workshops, repair cafés, and FabLabs have empowered individuals to learn how to create and mend objects themselves, challenging the concept of "planned obsolescence." Recent exhibitions, such as the "Repair Revolution" in Zurich in 2023, claim that "repairing is no longer a quick fix, but rather a cultural, social and economic practice that should be taken seriously and offers an alternative to the throwaway society," while exploring the concept of a repair society and the role of design in it (Museum für Gestaltung Zürich, 2023) (Fig. 2). Yet, critical questions remain: How can we transition to a repair-oriented society? And can the radical systemic change needed to address today's environmental and social crises be achieved through an evolutionary, bottom-up approach?
The roots of a societal movement centered on self-making, DIY, and repair can be traced back to 1970s Europe. Sparked by the 1973 oil crisis, rising consumerism, environmental awareness, and increased leisure time, this movement also emerged in response to top-down urban planning, widespread demolitions, and the transformation of built environments (Broes, 2024). It evolved through the 2000s, intersecting with advances in personalized digital design technologies and a renewed push for environmental responsibility. This period also saw the rise of "open-source and

Fig. 2 - Poster for the "Repair Revolution" exhibition (Museum für Gestaltung, Zurich, 31 March – 15 October 2023). Source: Zürich University of the Arts.

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Fig. 3 - The upgrade of a coat rack by student Elischa Bischof. Source: Langenberg 2022, 250–253.

postcapitalist practices of self-making" (Baier et al., 2016: 34-62).

Architecture, too, began to align more closely with monument preservation and circular economy strategies. This shift was evident in exhibitions like *Reduce, Reuse, Recycle* at the German Pavilion of the Venice Architecture Biennale (Petzet, Heilmeyer, 2012). Today, efforts to promote sustainability in the built environment range from advocating for ongoing maintenance, repair, and care – as seen in ARCH+ exhibitions like *The Great Repair* in Berlin and Paris, and *Open for Maintenance* at the 2023 Venice Biennale – to more radical proposals such as "A Moratorium on New Construction" (Malterre-Barthes, 2025). Despite their diversity, these initiatives share a common message: a call for greater sensitivity to existing materials, local resources, and built environments. They urge architecture to acknowledge and adapt the existing, rather than damaging and demolishing (Handoko et al., 2022). This ethos of sufficiency is also reflected in

more recent contributions, such as *Build of Site*, the Danish entry to the 19th Venice Architecture Biennale.

Maintenance and repair as a didactic concept
Repair, as a fundamental act of care, is essential for preserving the built environment and preventing its decay and eventual disuse. This principle is well-established in the field of monument preservation (Will, 2020; Langenberg, 2018; Schmidt, 2000; ICOMOS Germany, 1996). However, repair extends far beyond heritage conservation. In fields like mechanical engineering and industrial design, it has advanced significantly – thanks in part to rapid prototyping and other technological innovations.
In architecture, however, repair is still often associated with historical buildings or equates to a complete replacement of parts. This is partly due to the fact that strategies for repairing newer buildings made from complex, industrially produced components are not as well established as those for historical buildings. More critically, these newer, younger buildings are frequently not seen as "valuable," and their repair is often dismissed as "difficult" or "unnecessary." This reluctance may stem less from economic constraints and more from a consumerist mindset – one that shapes our production systems and our relationship with the built environment, and is reflected in financial, regulatory, and legal frameworks. Following the manufacturing sector, the construction sector is based on the idea of a binary system of "product" and "waste," making it difficult to legally and economically adapt and reuse existing building components (Streiff, Eckenstein, 2023). In this context, architecture and construction are seen less as evolving processes based on changing needs and more as products with a predetermined lifespan.
To challenge this mindset, the course *Repair* – launched in 2014 at the University of Applied Sciences in Munich and now continued at ETH Zurich, and the follow-up course *Upgrade* encourage students to "think and make" and "make things better" (Langenberg, 2018 and 2022a). They invite them to engage with industrially and mass-produced consumer objects with defects, reassess their value, and develop appropriate repair strategies. By integrating fundamental theories and methods of monument preservation into architecture and design teaching, *Repair*

Repair provides a framework that challenges students to rethink their.

Fig. 4 - The repair process of a concrete column and the floor tiles at Schatzalp in 2024. Credit: Professorship for Construction Heritage and Preservation, ETH Zurich.

provides a framework that challenges students to rethink their value system while considering whether to conserve, restore, reconstruct, or upgrade objects and their parts. Through hands-on repair work, students learn traditional manufacturing techniques while also exploring how seemingly irreparable items can be fixed, upcycled, or enhanced – sometimes using novel methods like additive manufacturing. The goal is to cultivate a mindset of sufficiency: to maintain and elevate the use, material, historical, or sentimental value of objects, to understand how things are assembled, and to preserve as much as possible while ensuring functionality. Later in the course, this question was explored further by asking: Can an object's components be visually and functionally improved, made more durable, or partially replaced so that the object – or, on a larger scale, a building – can transcend its original function and anticipated lifespan (Fig. 3)? This didactic approach opens new avenues for rethinking how objects are constructed and repaired. It raises crucial questions about materiality, liability, safety, financial feasibility, and design. It also prompts reflection on personal and societal motivations: What drives someone to repair rather than replace? How

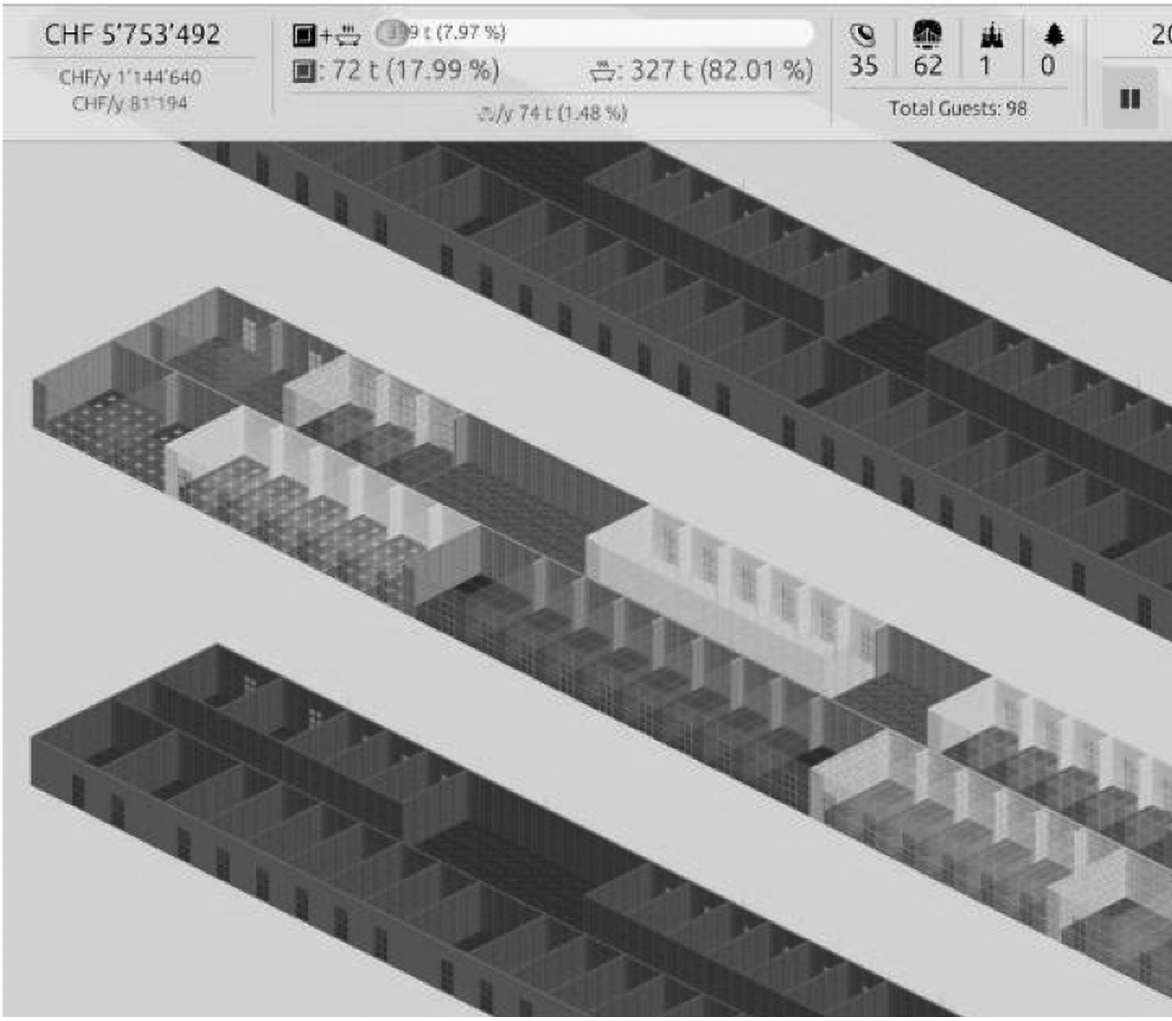


Fig. 5 - Doctor's office for Dr. Gustav Maurer, 1948, credit: Private Archive of Quintus Miller (left); the Doctor's office after the repair intervention in 2024. Credit: Christian Egli, Professorship for Construction Heritage and Preservation, ETH Zurich (right).

can we move beyond the "new" versus "old" binary? Ultimately, these are the very challenges that we must confront to sustain our built environment.
These questions are increasingly being explored in recent and forthcoming publications (Brooker, 2025; Stockhammer, 2020), and similar teaching models are now being adopted across institutions in Switzerland, Europe, and the United States. At the Lucerne University of Applied Sciences and Arts, for example, a *Repair/Making* course – modeled after those in Munich and Zurich – is offered to bachelor's students in object design (Baumgartner et al., 2024). At the Royal College of Art in London, master's students in interior design use the term *amending* to describe the re-designation of existing materials, aiming to "release environments and objects from perceived deficiencies and give them renewed purpose" (Retrovious, 2024). In the U.S., Markus Berger and Kate Irvin teach repair at the Rhode Island School of Design as "a contemporary expression of empowerment, agency, and resistance to our unmaking of the world and the environment" (Berger, Irvin, 2022: I).

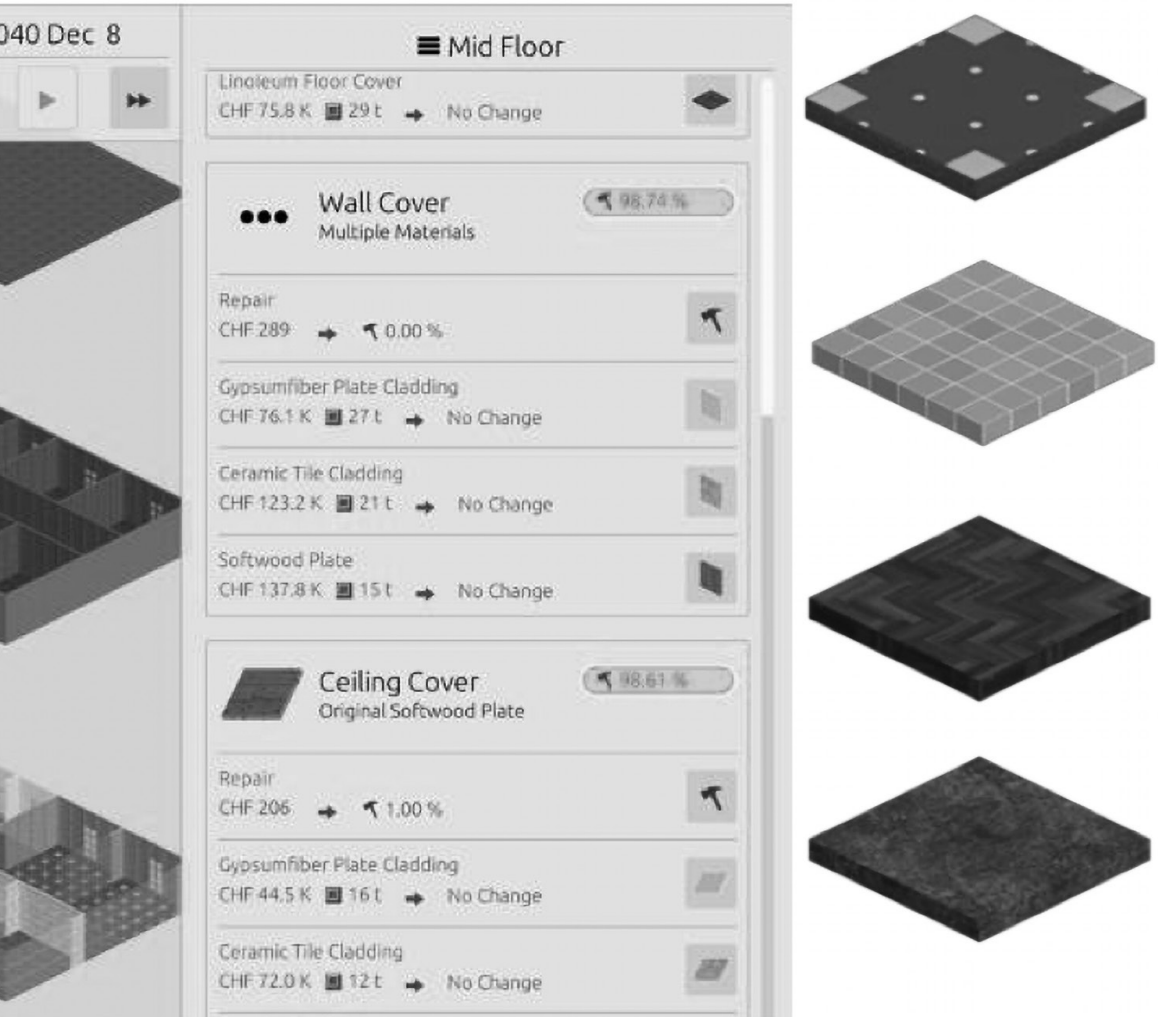
Keep in place

On an architectural scale, fostering a culture of sufficiency becomes more complex – and more impactful. The *Keep in Place* design-build studio at ETH Zurich exemplifies this shift by moving from object-level repair to building-scale interventions. Centered on the historic Hotel Schatzalp in Davos – a former sanatorium opened in 1900 which evolved into a hotel through extensions and adaptations without losing its authenticity – the teaching involves a semester-long-



discussion on how to understand and contribute to this process within the principle of sufficiency, as well as the planning and execution of the corresponding repair measures with the support of a team of interdisciplinary experts on site (Fig. 4, 5). The week-long intensive on-site workshop challenges students to navigate real-world constraints – materials, time, budget, and stakeholder needs – while gaining confidence in making, which is perhaps one of the most powerful agents in the mindset change.

Schatzalp also serves as the setting for a *(Re)Use Game*, an educational simulation developed at ETH Zurich (Kastner et al., 2023). The game invites players – students and schoolchildren alike – to manage the hotel's long-term transformation, balancing environ-



mental, financial, and user demands. Players must avoid bankruptcy, tourist loss, or triggering a "carbon footprint bomb," offering a playful yet serious exploration of sustainability trade-offs (Fig. 6). Professionals in architecture, construction, design, engineering, and real estate development are also a key audience for advancing repair-focused and sustainable practices. In Switzerland, institutions such as ETH Zurich, the University of Bern, and several Universities of Applied Sciences (Lucerne, Zürich, Winterthur, and Northwestern Switzerland) offer continuing education programs in sustainable design and construction – a promising development. However, current sustainability practices vary widely. They range from basic use of Life-Cycle Assessment

Fig. 6 - A Screenshot from the Schatzalp "(Re)Use Game." Designed as an educational tool, the game challenges players to strike a balance between the economic, ecological and structural aspects of maintaining a building over a long period of time by making repair decisions. Credit: Fabian Kastner, Professorship for Construction Heritage and Preservation, in collaboration with the Game Technology Center and Professorship for Sustainable Construction, ETH Zurich.

tools – which can be counterproductive if not paired with qualitative insights – to radical calls for halting all new construction. For buildings from the 1970s to 1990s, which are frequently targeted for deep renovation or demolition, a sustainable approach requires key actors in design, decision-making and planning processes to be empowered to develop transdisciplinary, out-of-the-box solutions that are sustainable in economic, ecological and social terms. Addressing this need, the *CAS ETH ReMain* (Repair and Maintenance) program, launched in 2024, equips professionals to develop scalable, systematic repair strategies for building components, façades, and services – grounded in real-world case studies (Langenberg, 2024).

Transcending disciplinary and generational boundaries

The didactic models described so far also need to be accompanied by the appropriate technological, regulatory and economic solutions to enable them to be scaled up and realized effectively. Today, innovative manufacturing processes such as digital fabrication offer promising repair strategies – not only for traditional materials but also for emerging ones like biopolymer composites (Chiujdea et al., 2024; Ramsgaard Thomsen, 2021-2026). In this context, engaging actors beyond disciplinary boundaries and incorporating them into the narrative to achieve a common goal is key to enabling a repair society.

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The *High-Tech for High-Tech* research project at ETH Zurich exemplifies this approach. It explores how digital fabrication can be used to repair complex façade constructions, producing spare parts to avoid full replacements when only a few components fail (Brenner, Langenberg, 2024). The project also evaluates the legal, economic, and environmental implications of these methods compared to conventional ones. As with the process at Schatzalp, the aim is to preserve as much of the original structure as possible, while ensuring structural integrity, safety, and financial feasibility (Fig. 7).

For such strategies to succeed long-term, they must be embraced and further developed by today's and tomorrow's digital natives. For instance, over the last decade, the fields of building research and construction history have made large strides in introducing novel surveillance and computational modelling

Fig. 7 - Façade of the CLA research facility of ETH Zurich, 2021. Credit: Matthias Brenner (left); Process picture during the fabrication of a custom spare part for the CLA façade system using WAAM, 2024. Credit: Matthias Brenner, High-Tech for "High-Tech," doctoral research project at ETH Zurich (right).

methods which provide detailed information on the geometry and construction of both historical and younger buildings and components (Cione et al., 2024; Häcki et al., 2024; Vandenabele et al., 2024). This is accompanied by a growing interest in research on the younger building stock from within this discipline using innovative methods (Parein et al., 2023; Van de Voorde et al., 2023). This enables the reverse engineering of components and the production of spare parts possible using computational design and manufacturing (Brenner et al., 2023). This progress is largely driven by an influx of a new generation of digitally skilled researchers and practitioners who blend traditional knowledge with cutting-edge technologies. However, it is important to note that the goal is not to rely blindly on technology; rather, it is to empower young professionals to apply their skills where the challenges are most urgent.

These challenges will become increasingly visible as younger generations take on the repair and preservation of the vast building stock from recent decades, and those that will be built soon. Monument preservation is already grappling with how to list and

maintain buildings from the 1970s to 1990s, with many unique constructions and details, which also present unique challenges (Raabe, 2025; Angermann et al., 2024; Brenner et al., 2024; Pearson, 2024). The increase in the digitalization of design, planning and construction are likely to present even bigger challenges, with experimental materials and structural details that are difficult to repair manually. The challenges related to the documentation, archival and reuse of construction-related processes and data continue to be subject of multiple projects (TUM, 2022-25; Van Mele et. al, 2017; Lynn, 2013). Recent research also explores cyber-physical systems for reuse, such as QR-coded components (Byers et al., 2024) or *spolia*, which are reused as physical relics elsewhere (Meier, 2020). Yet anticipating potential issues of repairability is just as critical to understanding future issues. This requires identifying which fabrication data to archive and developing measures to mitigate them. The project *Digital Construction Archive*, launched at ETH Zürich in 2024, addresses this need by investigating the long-term availability of digitally produced design and construction data as a basis for the repair or appropriate spare-part production of digitally fabricated objects (Langenberg 2024–2028). The objective is twofold: first, to support preservation institutions in identifying potential future monuments; and second, to lay the groundwork for the long-term preservation of digitally created architectural works, including related design and fabrication processes. Ideally, these efforts will converge, with digitally fluent younger generations taking on key roles in institutional preservation.

A new generation of researchers and professionals is pushing boundaries through interdisciplinary collaboration and innovative tools.

A Common Future Heritage

Across architecture, construction, preservation, structural design, engineering, and materials science, a new generation of researchers and professionals is pushing boundaries through interdisciplinary collaboration and innovative tools. They are developing low-impact materials, efficient structural systems, and streamlined manufacturing processes – while increasingly taking on leadership roles in academia and industry. Alumni of major initiatives like the Swiss *NCCR Digital Fabrication* and the EU's *innochain* have become influential educators, researchers, and

entrepreneurs, often with a deeper awareness of sustainability than previous generations. At the same time, research projects focusing on the repair and maintenance of historical and more recent buildings using new methodologies are emerging. As part of Switzerland's National Research Programme (NRP) 81 *Baukultur*, two projects launched in 2024 at USI's Accademia di Architettura and SUPSI in Ticino are rethinking maintenance practices and advocating for a shift from demolition to long-term care of cultural heritage. Young researchers from these programs are poised to promote more responsible approaches to the built environment. ETH Zurich's *Future Heritage* continuing education program, launched in 2023, addresses the challenges of preserving younger and digitally designed buildings – including overlooked suburban architecture. The program has been enthusiastically received by both emerging and experienced professionals who recognize the need for new skills and perspectives to address the complexities of future heritage.

While these individual efforts are promising, a broader shift in mindset requires both interdisciplinary and intergenerational collaboration in education, research, and outreach. There is potential in combining the disciplinary knowledge of older generations with the digital fluency and sustainability awareness of younger ones. This could foster a generation of *sustainable natives* – individuals who don't just critique existing systems but actively develop and implement better, more collaborative solutions. Such effort requires, above all, mutual respect, and a willingness to take on responsibility for the built environment from the outset (Langenberg, 2022b: 13-21). For monument preservation in particular, this is vital: its future legitimacy rests on its ability to recognize, assess, and protect the heritage of tomorrow (Radulescu, 2024).

This could foster a generation of *sustainable natives* – individuals who don't just critique existing systems but actively develop and implement better, more collaborative solutions.

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