Teaching with wood: reconciling future architects with the forest.

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Abstract

The potential of timber to be a strategic material in the pursuit of sustainability in architecture has been demonstrated in recent times by academic research (Ibañez, 2019) and practical experimentation. (Menges et al., 2016) These projects show how an effective use of timber in architecture should be linked to a change of approach towards this material: timber should not be seen as passive and exploitable but rather as a living entity whose complex ecology must be integrated with the design of buildings. Establishing a use of wood that builds on its ecology, rather than opposing and weakening it, can contribute to repairing the relation between mankind and environment. Architectural teaching can be crucial for this goal: design-build and live project initiatives, in which students can confront timber in different stages of design, can give future architects an idea of the extension of the ecology of this material and the environmental implications of its use in the built environment. This paper provides an intellectual framework for a renewed approach to working with timber in architectural education as an effective way of developing a better environmental and ecological conscience in future practitioners. Through a qualitative research approach, this work tries to understand the inspirations, reasons, goals, and commitments of educators choosing to work hands-on with timber with architecture students.

Keywords: timber, architecture education, design-build, sustainability, grounded theory

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Introduction

> *Man, I assert, fabricates by abstraction, ignoring and forgetting a great part of the qualities of what he uses, and concerning himself solely with clear and definite conditions, which can most often be simultaneously satisfied, not by a single material, but by several kinds. […] The artisan cannot do his work without violating or disarranging an order by the forces which he applies to matter in order to adapt it to the idea he wishes to imitate, and to the usage he intends. He is therefore inevitably led to produce objects of which the whole is always a degree below the level of their parts. If he make a table, the assembling of its parts results in a much less complex arrangement than that of the texture of the fibers of the wood, and it brings crudely together in a certain unnatural order, pieces of a big tree, which had grown and developed when otherwise related. (Valéry, 1923)*

In the introduction of his 1923 book *Eupalinos ou l'Architecte*, Paul Valery explains how an artisan should always use just a few of the properties of a natural material to achieve his goals. To be creative, humans need to be able to abstract and simplify complex natural phenomena to a degree over which they can then control and make use of them.

The United Nations' 2030 Agenda for Sustainable Development identifies climate change as one of the greatest challenges of our time. The construction and operation of buildings is one of the largest contributors of Greenhouse Gases (GHG) (United Nations Environment Programme, 2020). The production of materials such as structural steel, concrete, and masonry all entail energy-intensive manufacturing processes to transform raw materials into products, generating large volumes of carbon dioxide. In a time where sustainability is of paramount importance, employing natural materials in the construction and architectural sectors could potentially mitigate environmental impacts. However, it is essential to gain a deeper understanding of the complex implications associated with their usage.

By using carbon-absorbing wood in place of carbon-emitting materials, architects can contribute to the net reduction of GHG generated by buildings in their construction and operation (Gu et al., 2022; Morris et al., 2021). Under certain conditions, the use of structural wood instead of carbon-intensive materials is now regarded as one of the most promising means of achieving our shared environmental goals. Architectural education can have a crucial role in developing and disseminating this strategy. Our research shows how timber is well adapted to use in an educational context: its ease of use, versatility, and availability make it an ideal material to be handled by inexperienced students in hands-on architectural experiments. In this paper, we explore the implications of the hands-on use of timber by students in architecture education vis-à-vis present-day environmental challenges. We identified several case studies of educational initiatives in which students engage in the hands-on use of timber and analysed them with a qualitative research method. Through interviews with architectural educators and scholars, this work has explored the material, architectural, educational, ecological, and political implications of the use of timber in architectural education.

This article summarises the approach and initial findings of this work. It first illustrates how the understanding of the sustainability of timber is evolving towards a more holistic approach that focuses on the ecological and non-hierarchical network of relationships of which it is part. Then, it explores the pedagogical potential of timber for a more effective teaching of sustainability. It

then illustrates the research process and findings, linking it to the initial critical findings of the work and reflecting on how more the inclusion of hands-on use of timber in educational settings can contribute to create more environmentally conscious practitioners that can promote the ecological integration of designed spatial transformations.

A changing approach to timber

Of all the structural building materials, timber is recognised as having the greatest potential for addressing the urgent need to reduce the carbon emissions of architecture and construction (Moe, 2019). If grown sustainably, wood is a naturally renewable material which sequesters carbon from the atmosphere and stores it in forests (as trees grow) and in timber products (after they have been harvested) (Morris et al., 2021; Taverna et al., 2007). The potential for sustainable production of timber products can motivate more sustainable forest management practices, as well as to draw attention to the potential of wood as part of the circular economy (Ilgın & Karjalainen, 2022). With good design, timber buildings can be dismantled at the end of their useable lives and reused, recycled, or burned to generate energy. In addition, the thermal and structural properties of wood make it an ideal material for effective building insulation (Kosny et al., 2014) thus lowering energy consumption and contributing to a reduction in net carbon emission.

However, the sustainability of timber is conditional on many things. Firstly, forestry practices have an important role in determining the sustainability of timber production: timber harvesting should be carried out in a way that preserves biodiversity, avoiding clearcuts and monoculture. Conventional timber production, in which trees are felled, trimmed of branches, planed, and graded can also waste an important part of the overall wood biomass. While many timber producers use these offcuts for paper, board, textiles and energy production, the handling of these waste products can be crucial for limiting the carbon footprint of the industry.

Secondly, the use of chemicals in engineered wood products, useful for obtaining outstanding structural properties, can also significantly impair the sustainability of timber in construction. Cross-laminated timber (CLT) and glue-laminated timber (glulam), for example, must be handled differently at the end of its useful life, if the chemicals within them (such as resin glues) are not released into the atmosphere.

Thirdly, how timber is disassembled and disposed of at the end of a building's life is crucial for its effectiveness as carbon storage. The multinational research project *ForestValue - Innovating the forest-based bioeconomy*,[14] for example, has brought together more than thirty members in a consortium to research how the forestry and construction systems can be modernised and made more sustainable, including in the re-use of materials in existing buildings in the project *InFutUReWood*.[15]

[14] EU Horizon grant # 773324, October 2017 – March 2023. https://cordis.europa.eu/project/id/773324
[15] https://www.infuturewood.info/

Overall sustainability is not achieved simply by using more timber, or by choosing timber instead of steel or concrete. Rather, the building must be conceived as part of a wider sustainable process. More and more examples are emerging in the architectural practice of wooden buildings designed from the outset to be disassembled, such as *HasleTre*, a 3000m^2 four-storey office building recently completed in Oslo by the practice OsloTre.

Recent literature (Ibañez et al., 2019) describes wood as just one of the products of the complex ecology of the forest. Analysing wood at different scales, from the molecular to the territorial, can reveal the extension and complexity of its impacts on the environment allowing for a better understanding of its role towards sustainability. Building with timber can be seen as just one moment in the wider and ongoing ecological cycle of the forest, thus promoting a more conscious use of this material in the building industry. Through qualitative research methodologies, this paper explores how this expanded understanding and consciousness can be developed in architectural education involving hands-on engagement with wood.

Timber in architectural education: a transparent ecology

An ecology is a web of ever-changing relations between parts. To act sustainably in relation to any ecological system is to preserve a balance which does not extract more than the system can regenerate. Consciousness of the complexity of an ecological system is necessary to act upon it in a sustainable way. Timothy Morton defines this kind of ecological thought as “thinking big.” (Morton, 2010) Ecologies are interconnected systems and a change in any of their elements can influence a number of other ones. In northern Sweden, for example, the clearcutting of forests and replanting with monocultural plantations has been found to dramatically reduce hanging lichen populations, thereby limiting the availability of food for reindeer in the winter months (Kivinen et al., 2010). Thinking ecologically means not only caring about the sustainability of a single material but also being able to comprehend the complexity of an ecological system.

We make two contentions in this article: that the ecology of timber is more evident than the ecologies of alternative structural building materials, and that this *transparent ecology* can be a powerful pedagogical tool.
Firstly, the ecology of timber is more evident than that of concrete or steel, which are far removed and extensively transformed from the raw materials of their origin. Whereas the raw minerals used to make masonry, steel or cement are produced through geological processes lasting millions of years, the ecological cycle of wood has a duration which is comparable to that of human life. The grain of a piece of timber and the growth rings of a tree trunk are visible reminders of the short and tangible growth of wood. We argue that these characteristics allow for a more immediate understanding of the ecological impact of timber, which is ideal for pedagogical settings with limited time and resources.

Secondly, and consequently, we contend that timber has a *transparent ecology,* one which we believe can be a powerful pedagogical tool for an effective teaching of sustainability. If supported to interrogate its origins, students engaging with

wood can observe different phases of its growth, production and use, having a more complete overview of the ecological cycle of a building material. The best opportunities for students of architecture to confront and comprehend the transparent ecology of timber are through hands-on experience of the material. Through that, architecture students can acknowledge the technical, environmental, economic, and social implications of material choice in design and building.

Hands-on architectural education is in fact recognised as helping students to grasp the complexity of the implementation of a spatial program (Bader & Lepik, 2020; Carpenter & Hoffman, 1997; Pallasmaa, 2009). It can assume many forms. On a small scale, students might engage in a structural engineering workshop in which they use affordable modelling materials to construct bridges or towers, perhaps tested to destruction. At full-scale, design-build and live projects give students the chance to handle building materials in the construction of something tangible for both the design team and the client. We are careful to distinguish between, on the one hand, design-build projects in which students engage in the realisation of a building whose entire process, from the brief to the realisation happens within the educational institution, and on the other, initiatives that involve students in the process of designing and realising projects for an external client (Brown & Russel, 2022). As emerged in our research, many of these initiatives use wood because of its ready availability and ease of use.

The projects we analysed show how timber allows for explorations at different interconnected scales, from the molecular dimension that affects the material's thermal and structural properties, to the territorial, that concerns relations with the environment and all the human and non-human stakeholders that interact with the forest (Ibañez et al., 2019).

For example, at the University of Stuttgart, Luis Orozco describes how students can study the molecular properties of timber to be able to program its reaction to changing environmental conditions:

> *...within the Material Programming research group it is about using 3D printing to be able to affect the characteristics, static or otherwise, of the product and with timber we believe that we can control, or at least harness, these characteristics by intelligently looking at everything all the way down from the micro level of cell structure. (ICD/ITKE interview)*

At the Architectural Association's rural Hooke Park campus in Dorset, England, teachers set out to challenge students to consider the continuous relation with the forest as a strategy to achieve a holistic understanding of sustainability:

> *The holistic ambition of the courses is that the site is our material library as well as our building site and, therefore, making sure that there is no distance between the resource and the building material and the building site make it a holistic approach towards architecture. (Hooke Park interview)*

In the peripatetic Studio in the Woods summer school, timber is considered as a material that can be very communicative about the context:

> *There is often a very complex* […] *and rich and multi-layered story that is easier to draw out of timber than it is with other materials like steel or concrete which can come from anywhere. (Studio in the Woods interview)*

In our work, we wanted to focus on the reasons, strategies, and outcomes of these initiatives. The aim was to frame the phenomenon of the use of wood in architectural education and understand its potential vis-à-vis the challenges of contemporary architecture practice.

A qualitative research method

Funded by the Kempe Foundations through a two-year postdoctoral fellowship December 2020 – December 2022) at Umeå School of Architecture, our research was driven by the desire to understand the inspirations, reasons, goals and commitments of educators choosing to work hands-on with timber with architecture students.

We knew, through early literature reviews and resolved questions from preceding research (Brown, 2012) that there are many examples of these kinds of hands-on pedagogies. Seeking new theories and new understandings about these projects, we adopted a qualitative research methodology and employed Grounded Theory methods to developing new knowledge. Grounded Theory provides us with a framework for coding: a process of conceptual abstraction that assigns concepts to singular incidences in the data, most often interview transcripts. (Bryant & Charmaz, 2019; Charmaz, 2014)
Our research followed six steps:

1. Literature review
2. Initial assumptions
3. Mapping and selection of case studies
4. Interviews
5. Coding of interviews and data analysis
6. Critical synthesis

Literature review

We started our research by analysing literature on the themes of design-build and live-project pedagogies, wood construction and ecology. Additionally supported by resolved questions from preceding research (Brown, 2012), we acknowledged that there are many examples of these kinds of hands-on pedagogies. We could also observe how the ecological understanding of wood as a material is being explored in a more holistic way.

Initial assumptions from the literature review

Following the preliminary literature review, we proposed a list of six initial assumptions to frame our work. These are the following:

- For architecture students, being involved in the realisation of an actual building can make more tangible the nature of architectural design and construction;
- Design-build projects and live projects can give evidence of this assumption, together with projects realised within research centres.
- Wood is a versatile material that can be used in many ways and at different levels of technological complexity, from the simplest to the most advanced, and this versatility makes it particularly suitable to be used in design-build/live projects;
- Wood has the potential to be more sustainable than steel, concrete, or masonry:
- The ecology of wood is a complex system that involves many different actors (including forests, fauna, human communities, economies, and politics) which necessitates the avoidance of reductionism when approaching this topic;
- We think that the use of wood in architectural education initiatives like design-build/live projects can be a strategy to effectively promote sustainability among students in architecture and, consequently, in the actual practice of architecture.

These assumptions helped us clarifying our scope and position. They also constituted the introduction to the questions of the interviews.

Mapping

Then we mapped hands-on educational initiatives using wood internationally and subsequently selected a smaller number of case studies (Figure 11).

Figure 11 List of case studies

Initiative	Reference institution	Country	Typology
ICD/ITKE - ITECH	University of Stuttgart	Germany	Research centre - M.Sc. program
UoN Design+Build Studio	University of Nottingham	United Kingdom - South Africa	Course
AA Hooke Park Design+Build	Architectural Association	United Kingdom	Research centre with study programs
InSitu Project	Hong Kong Polytecnic University Shenzhen University	Hong Kong	Non-profit association and course
IBOIS - Studio Weinand	EPFL	Switzerland	Research centre with study programs
Studio in the woods	Independent	United Kingdom	Independent short workshop
Gramazio Kohler Research	ETH Zurich	Switzerland	Research centre with study program
Aalto Wood Program	Aalto University	Finland	Study program
GerHub - Rural Urban Framework	University of Hong Kong	Hong Kong	Non-profit association and course

These were selected based on the opportunity that they provide to first or second-cycle students in higher education to engage with the actual realization of a wooden building or structure as part of their studies. The process of identifying case studies was not straightforward. The literature about such projects is not homogeneous: some initiatives have been the subject of books and publications (Menges et al., 2016; Verderber et al., 2019), some are publicized with videos or other media online, whereas others barely have a website.

Interviews

We then arranged interviews with one or two teachers responsible for each the selected case studies, to use them as main data. These conversations were set up to give the interviewees the possibility to speak freely while remaining in a common framework of subjects. They were carried out online through video-conferencing platforms and lasted about one hour. The interviewees were sent the questions in advance in a written document that included the list of research assumptions mentioned before. The interview schedule was semi-structured, organised around themes: general information; timber; Design/Architecture; ecology; politics. This allowed the interviewees to expand on the various topics, touching on unforeseen aspects that enriched the data.

Figure 12 The initial tentative coding was carried out by reporting the synthetic sentences on sticky notes and by grouping them on a whiteboard

Coding

Subsequently, a four-step process of coding was employed to allow a grounded theory to emerge from the interviews. In the first step, single significant concepts in the interviews were marked with a short sentence aimed at synthesizing them. The second step consisted in tentatively assembling the short sentences from across all the interviews under general, preliminary categories (Figure 12). This allowed a broad overview of the results of the interviews and the emergence of common themes shared by all the cases. It also showed how the initial categorisation and assumptions were basically correct and agreed upon by the interviewee: the themes that emerged were coherent with the themes of the interview and didn't contradict the initial assumptions.

Figure 13 The process of coding

Interview citation	Initial synthesis	Codes
"In many ways we like to reverse the understanding that we, as architects at practice, don't make a demand on the forest, like for example a certain volume of oak or whatever, but we actually turn it around and see what is available in the forest for us to build with."	Reversing the extractionist approach towards the forest.	• Social engagement • Ecological thinking • Role of wood • Ecological awareness • Building economy
"Our goal is still to use as little material as possible and not as much as we can because this would of course increase the carbon storage capacities of the building but also the impact on the forests. It would be a good factor in our life cycle analysis, but we're trying to reduce its use as much as we can."	Sustainability through reduction of materials' use	• Material economy • Material understanding • Ecological thinking • Ecological awareness • Alternative education • Building economy
"What we want to make students understand is that digital computational control, sensing feedback, robotic fabrication can help to work with natural materials in a different way because we can better control tolerances and behaviours."	Transmit to students that technology can help handle natural materials in a more ecological way	• Ecological understanding • Ecological awareness • Alternative education • Design/spatial innovation

In the third step, we were able to draft a final list of codes (Figure 14). The choice and definition of these codes have been the result of alternating inductive and deductive approaches: the structure of the interview guided the interviewee towards the themes of the research (inductive), while the openness of the interview allowed unexpected themes to emerge (deductive). This process is reflected in the choice to group the final codes under the same topics that structured the interview.

Figure 14 The codes and their definitions

Theme	Code	Definition
Wood	Carbon footprint	Evaluation of the sustainability of the process
	Proximity	Local procurement and/or manufacturing of wood
	Accessibility	Ease of procurement
	Versatility	Ease and flexibility of use
Design / Architecture	Building economy	Resource efficiency in building
	Buildability	Concern for an easy and effective realisation of a design
	Building process	Evolution of the activities related to building
	Design/spatial innovation	Evolution of design process and outcomes
Education	Multidisciplinarity	Inclusion of different expertise
	Hands-on learning	Active engagement of students in building
	Role of wood	Ways in which wood is used for teaching
	Ecological awareness	Innovation in teaching ecology
	Alternative education	Differentiating from standard architecture pedagogy
Ecology / Sustainability	Material economy	Optimisation of material use
	Local dimension	Integration with the immediate context
	Social engagement	The ethical and political concerns of the project
	Ecological understanding	Framing spatial transformations in their complex network of environmental interactions
	Material understanding	Comprehension and exploitation of the properties of wood
Politics	Local knowledge	Expertise from local stakeholders
	Collaboration	Inclusion of several viewpoints and expertise
	Political/ethical statements	An opportunity to express political values.
	Stakeholders	Involvement of actors affected by the project
	Social impact	Influence of the initiative on society

The fourth step consisted in reviewing all the synthetic sentences and assigning them one or more codes, as visible in Figure 13. These codes were then counted, with results visible in Figure 15. This process allowed us to assess both the accuracy of our six initial assumptions and to identify new themes.

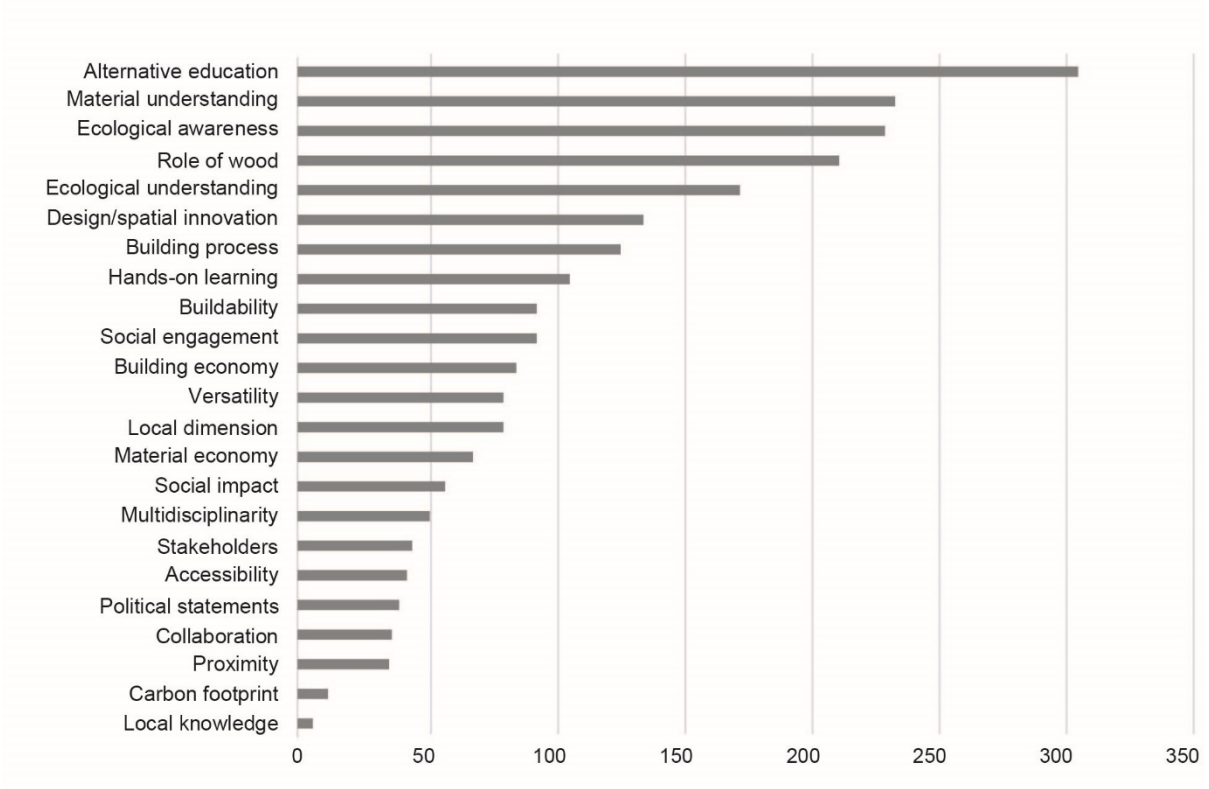

Figure 15 Code counting

Critical synthesis

In the last step, we have attempted a critical synthesis of the data, in light of our initial assumptions and trying to identify the potential of hands-on architecture pedagogy using wood as a building material. The results of this activity are illustrated in the following paragraph.

Themes: promoting sustainability in and through architecture education

The classification shown in Figure 15 is not without bias: the limited number of case studies makes the data not statistically significant; the counting of codes is not directly related to the relevance of the single topic but might just show the level of interest of the interviewee; the answers to the interview were somewhat induced by the way in which questions are posed and by the fact that they were introduced by a list of clear statements. Nevertheless, some interesting patterns emerge from this work that could generate further reflection (Flyvbjerg, 2006).
Figure 15 shows an account of how many times each code has appeared in all the interviews. The graph can be read by distinguishing the upper, middle, and lower part of the ranking. We can see how the more recurring codes are related to the innovation of teaching and ecological understanding, with a particular focus on the role of wood. In the middle part of the graph, we find topics relating to strategies and potentials of timber and its use in hands-on education. In the third part of the graph, we can see more social topics and, significantly, we find “carbon footprint” in the second-last position. This spread of codes shows how the main interest of the interviewees is about transforming architecture practice through education towards a more effective approach to sustainability. Wood and timber are the strategic elements of this goal, constituting both a sustainable material

and an effective pedagogical tool that can show students an example of a complete material ecology. This also shows how the strategies to achieve this goal can vary: the different initiatives balance education and research in different ways, they focus on different aspects related to timber in construction, they use different technologies, and have different ways of managing the involvement of students.

On the one hand, all these elements confirm our initial assumptions about the potential of wood in the pedagogy of ecology. On the other, new themes emerge from this qualitative research work that could foster further reflection on architecture pedagogy and its role in promoting sustainable practices. These themes relate to the evolution of architecture education, the role of hands-on experiences for students, the role of wood in education, the role of research in achieving a more sustainable use of timber, the importance of the local dimension of timber for its sustainability.

Innovating architecture education towards sustainability

The interviewees manifested a commitment in providing alternative and innovative teaching methods. This is often characterized by a critique towards conventional architecture pedagogy, seen as detached from real-world issues and from the practical and ethical aspects of the profession. Hands-on education is seen as a more effective method for transmitting useful and concrete knowledge to students, because it allows them to confront with the actual realisation of their design intentions. This is considered crucial for disseminating among future practitioners an understanding of timber that will allow them to effectively use it in a sustainable and conscious way. The importance of ecological awareness, understood as a consciousness of the complex environmental implications of design and material choices, is also one of the common concerns of the case studies, that share the goal to make student understand the complexity and specificities of timber. Therefore, steering towards a more practical approach in architecture education is considered a necessary change for the promotion of sustainability in design practice.

Teaching the complexity of a material through hands-on experience

Having a direct experience of a building materials is, in the opinion of the interviewees, a good way to learn about its peculiarities. This is not only related to its physical and structural characteristics but also to the way it is harvested, produced, procured, and reused, raising concerns about the sustainability of the whole process. Within these courses, students have the opportunity to experience many different phases of the use of wood in a building and to confront with the many characteristics and opportunities of this material. They can observe and experience an example of a full building process and all the issues related to the material realisation of a project. This complete overview can be a powerful pedagogic tool, aiding students to understand the complex implications of material choices in the design and construction process.

Taking advantage of the properties of wood for an effective pedagogy

In all cases, the versatility of wood is what allows students to be involved in a full building process. Being able to participate in its harvesting, procurement, sawing, assemblage, fabrication, and disposal can be a powerful educational experience that gives students a comprehensive understanding of the problems related to material choices in architecture. The possibility to use timber at different levels of technological complexity allows for a wide range of applications and for experimenting with both simple, time- and cost-effective methods, and with advanced computational approaches.

Innovating wood building to enhance sustainability

A common characteristic of the case studies is that they experiment with timber to enhance its sustainability. Both the low- and high-tech approaches share the goal of optimising resources to achieve sustainability. While the low-tech initiatives focus on social and cultural sustainability, pursuing the quick, cheap,

and reliable delivery of a well-functioning building, the high-tech initiatives are more concerned with exploring the properties of timber to exploit them in the most effective way, thus lowering the quantity of material used. This also shows once again how the sustainability of timber is conditional and linked to a careful and conscious design approach.

Stressing the importance of the local dimension of building

At different levels, all the interviewees are concerned with the origin of the materials they use. All the initiatives are in areas where wood is either abundant or readily available, and, in some cases, an integral part of the local culture. Procuring timber locally can be advantageous in many aspects: transport alone affects both the cost and the carbon footprint of the material; the use of local timber can be coupled with the use of local knowledge; the use of local materials can generate designs that harmonise better with the landscape. Proximity is therefore considered a crucial part of the wider sustainability strategy.

Possible future research

There are some limitations to our research. Firstly, we analysed a limited number of case studies and considered only the perspective of teachers and researchers. For future research, it would be beneficial to investigate the points of view of other actors involved in these initiatives, such as students, stakeholders in industry, local communities, and politicians. Secondly, to focus on the pedagogical potential of timber, we inevitably could not devote the same attention to other building materials. While the widespread prevalence of design-build projects working in wood would suggest fewer are working in steel or concrete, the negative environmental impact of these materials does not preclude similar research. The very fact that future architects will need to specify fossil and mineral materials more sensitively would suggest that hands-on experience of them in education is needed.

Conclusion: reconciling future architects with the forest

The themes that have emerged from our research can help in framing the role and potential of the hands-on use of timber in architecture education. We found that educators and researchers pursue the promotion of sustainable practices in architecture design putting students in direct contact with the material, its physical characteristics, and the natural and industrial processes necessary for its production and use. In this analysis, we can read a tendency towards a rethinking of wood in a more complex way (Hudert & Pfeiffer, 2019), that considers its impacts and relations through its whole life cycle, as opposed to a traditional type of teaching that sees the material as a passive and secondary element to the project. Understanding the motivations, problems and opportunities linked to the use of timber in the building industry is seen to transmit a more conscious approach to sustainability, that takes into account the complex ecology of the building in a more complete way. This focus on complexity can be read as an ecological approach (Morton, 2010) to sustainability and to architecture practice: considering the complex web of relations that a building establishes with the environment through all phases of its life is a way to acknowledge the real extent of the impact of architectural practice. This ecological consciousness can therefore be the basis for a truly sustainable architecture. What these initiatives have in common is that they look at timber as a tool for achieving sustainability: not just material sustainability, but an expanded social, economic, and political sustainability that compliments a more sustainable approach to the environment. Moreover, this sustainability of timber, together with its versatility, accessibility, and ease of use, make it an ideal material for the pedagogy of ecology.

Pedagogy itself is seen as a field that needs to be innovated and evolved towards a more conscious but at the same time pragmatic and demystifying approach to sustainability. In the analysed case studies, the hands-on teaching of architecture is seen to overcome normative studio education and its alienation from real-world

issues, with specific attention to sustainability concerns. We interpret the hands-on use of timber in architecture education as a way for educators to make up for teaching that has neglected the ecological relationships of the building with its environment, re-establishing a connection between design, materiality, society, and environment. Understanding wood as the product of the forest rather than that of a single tree can be a way to effectively represent this evolution towards a more complex understanding of this material. The forest is thus interpreted as a living entity constituted by the network of relationships that keeps together all the forms of life that populate it. We propose that a further and deeper reconciliation of the architect with the forest, not as a source of raw material but as an environment which we are part of, can positively contribute to the teaching and practice of truly sustainable architecture.

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