Evolving contemporary timber tectonics through digital fabrication and local wood-cycle optimization in the context of the Netherlands

Research Plan

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07.11.2024

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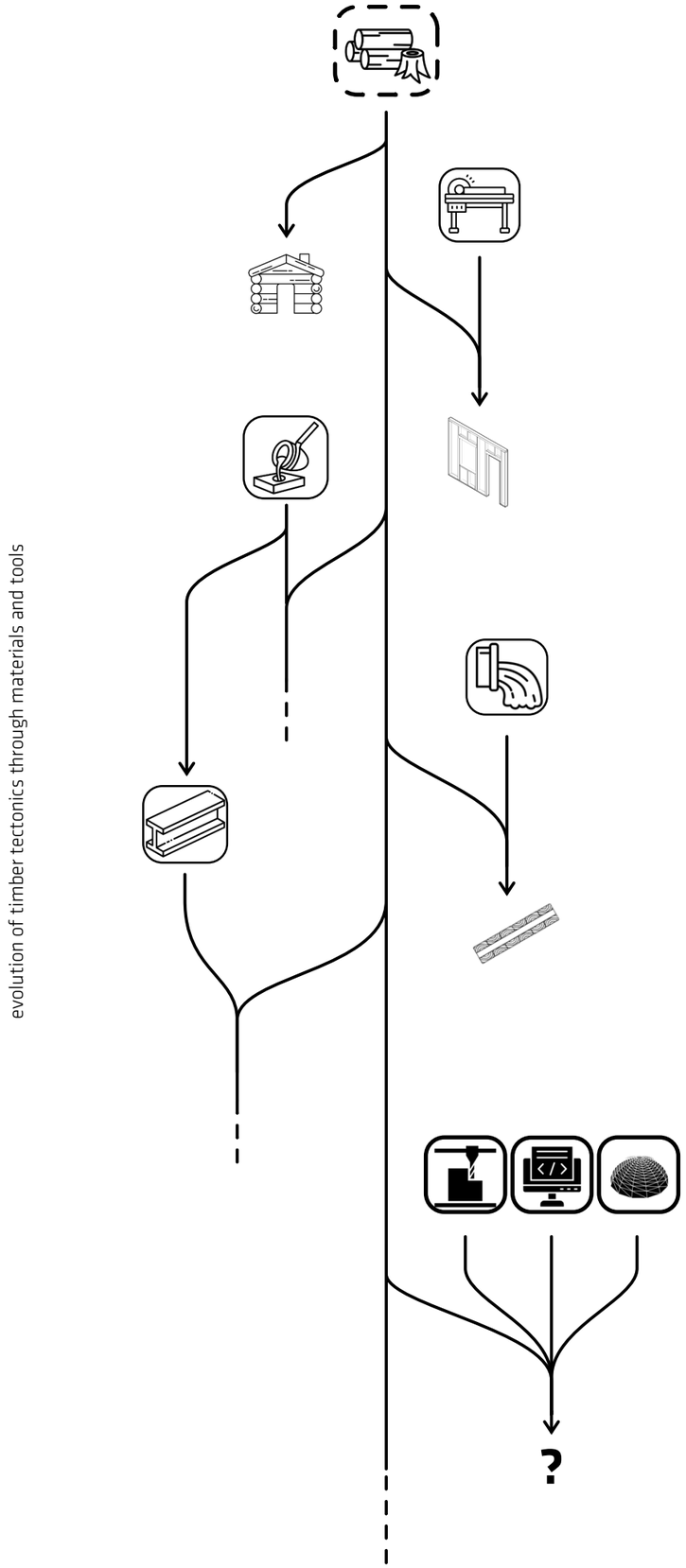
The increasing interest in timber as a sustainable building material has led to a growing focus on how it can be used to create innovative architectural solutions. However, the widespread adoption of timber often results in replicating concrete or steel construction methods, which fails to unlock the full potential of wood as a material. To fully realize its unique properties, a new tectonic approach for timber must be developed, one that takes advantage of modern digital fabrication methods and parametric design tools.

In the Netherlands, where forestry resources are limited and urban density is high, implementing a locally adapted, circular wood-cycle is essential to support sustainable timber construction. This research aims to explore how timber's structural and expressive qualities can evolve into a modern architectural approach, shaped by the potential of digital fabrication and the necessity of a sustainable lifecycle that suits Dutch conditions. Achieving this vision will require a rethinking of the entire wood lifecycle, from responsible sourcing and efficient processing to design for disassembly, ensuring that creative architectural freedom is supported by both ecological responsibility and regional adaptability.

How will contemporary timber tectonics evolve through digital fabrication and local wood-cycle optimization to redefine our current formal vocabulary in the context of the Netherlands?



sub questions

- *How can digital fabrication and parametric design drive new architectural forms in timber tectonics?*

This question explores how modern digital tools can push the boundaries of timber construction, allowing for the creation of dynamic, non-standardized forms that challenge the traditional perception of timber as a material suited only for modular or rectilinear systems.

- *What changes need to be made to the local lifecycle of wood, from cultivation to reuse, to support a more innovative and flexible approach to timber construction?*

Investigate how the entire lifecycle of wood must be adapted to enable a circular economy, ensuring that the material can support a more creative and flexible use in construction. This includes rethinking how wood is processed, transported, and reassembled for future use.

- *How can the principles of sustainability and efficiency be integrated into timber tectonics without compromising architectural expression?*

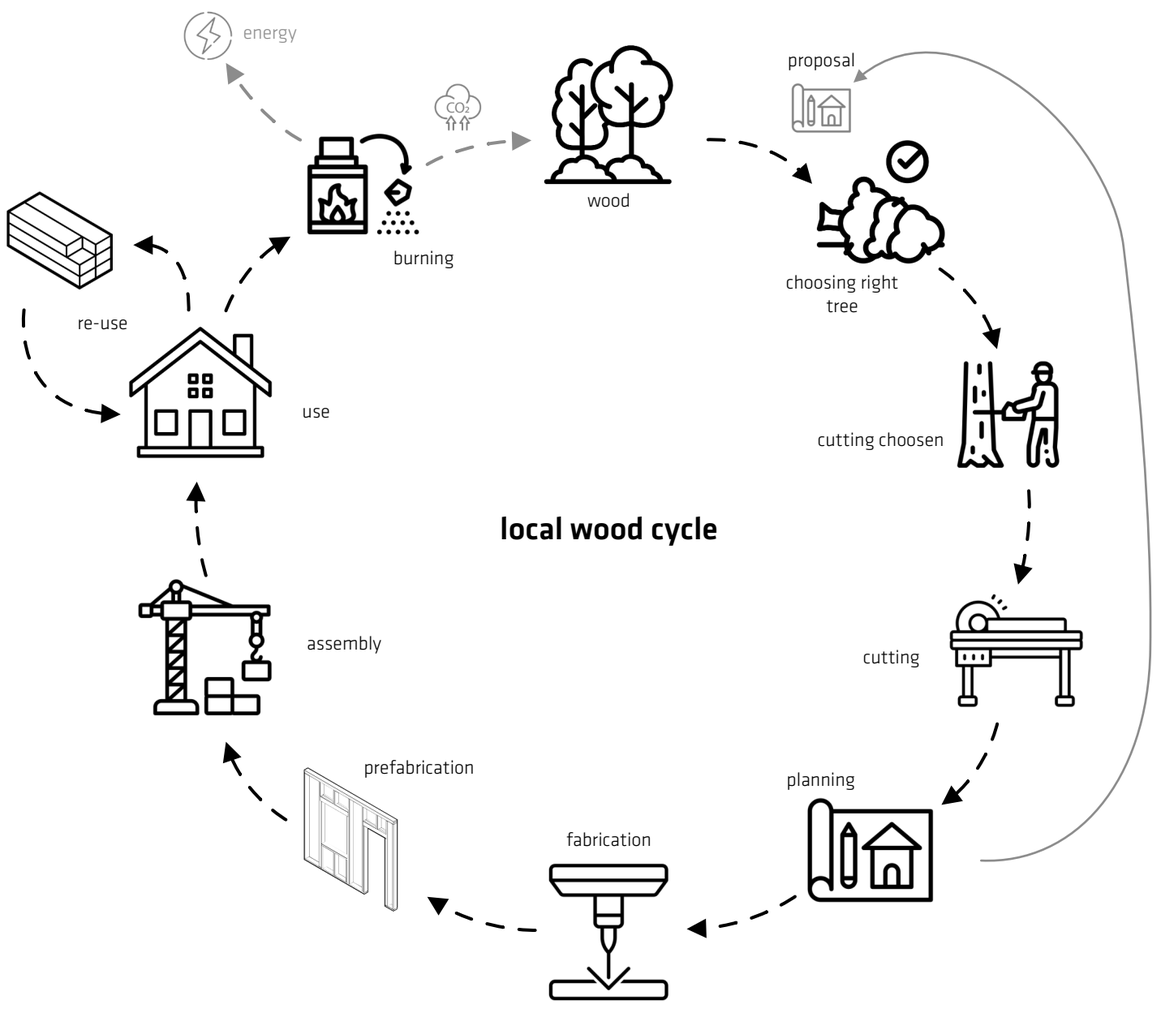
Examine how sustainability goals (CO2 reduction, low waste, ...) can be aligned with the expressive potential of timber construction, ensuring that architectural innovation and environmental responsibility coexist.

- *How can local, cultural and environmental conditions influence the development of a timber-based architectural form language?*

Investigate how local traditions, available resources, and environmental factors can shape the development of timber tectonics, ensuring that designs are rooted in the specific needs and identity of their location.

- *What adjustments to current forestry, processing, and construction practices are necessary to create a closed-loop wood cycle specifically suited to the environmental and cultural context of the Netherlands?*

This subquestion focuses on examining what changes are needed at each stage of the wood lifecycle to establish a circular, local system that aligns with the unique geographical, ecological, and cultural factors of the Netherlands. It allows you to investigate specific adaptations within forestry, material processing, and timber construction that would make the cycle both viable and locally relevant.



theoretical framework

Timber's growing prominence as a sustainable building material brings both opportunities and challenges in the context of Dutch environmental conditions, forestry resources, and construction practices. In order to fully leverage timber's potential in the Netherlands, a unique approach to timber construction—one that is responsive to local ecological and cultural conditions—is essential. This study aims to redefine timber tectonics by celebrating wood's unique material qualities—such as flexibility, grain, and texture—in forms that align with the Dutch climate and cultural context.

Dutch timber construction traditionally emphasizes functional, modular designs. This research aims to move beyond these limitations by developing a timber-based architectural language rooted in material expression and structural innovation with local resources..

Digital fabrication tools (e.g., CNC milling, robotic fabrication) and parametric design enable precise and adaptable timber structures. These tools allow for innovative, waste-minimizing forms that respond to Dutch constraints such as dense urban environments and sustainable construction mandates. This research will explore how digital tools can shape a Dutch timber tectonic, supporting efficiency and material responsibility while achieving architectural richness while at the same time trying to explore how these tools can shape a new way of thinking the material wood when designing with it.

To establish a circular wood-cycle in the Netherlands, timber's lifecycle must include sustainable sourcing, efficient processing, and planned disassembly for reuse. Due to limited forestry resources, the Dutch context requires unique solutions, including reclaimed wood and localized processing. This study will assess how a circular, locally adapted lifecycle for timber can address urban constraints, reduce waste, and foster sustainable building practices in the Netherlands.

This research is also inspired by contemporary studios like Studio Precht, BIG, and Hermann Kaufmann, who leverage digital fabrication and parametric design to push timber beyond traditional forms, exploring new ways to craft expressive, localized architectural identities through wood. These influential practices underline the potential of a Dutch timber architecture that not only adapts to the unique environmental and urban conditions of the Netherlands but also reimagines timber as an innovative, sustainable building material.

methodology

This research will employ a combination of literature review, case studies, design experimentation, prototyping, and lifecycle analysis to develop a comprehensive understanding of timber tectonics, local circular wood cycles, and their application within Dutch architecture. Each phase is structured to build upon the previous findings, leading to an architectural design proposal that demonstrates a feasible, sustainable timber solution suited to the Netherlands.

Literature Review

The research begins with a review of existing studies on timber construction, digital fabrication, parametric design, and the circular lifecycle of wood. This phase aims to establish a theoretical foundation by exploring current limitations in timber tectonics and examining how emerging technologies, like CNC milling and robotic fabrication, can enhance timber's architectural potential. The review will pay particular attention to challenges unique to the Dutch context, such as limited forestry resources and dense urban environments, to frame the scope of the study.

Case Study Research

Following the literature review, a selection of architectural case studies will be analyzed, focusing on projects that integrate digital fabrication and parametric design in timber construction. Notable examples include Kengo Kuma's Tamedia Building, ICD/ITKE research pavilions, and Studio Precht's innovative timber designs. Additionally I will meet with wood experts in Germany, discussing their projects and potentials they see for future improvements in the industry. I will also visit their facilities in forestry and production to get a better understanding of the underlying structures. These projects provide valuable insights into how timber tectonics can be pushed toward more expressive forms, while also maintaining sustainable practices. Additionally how the connection between experts and planners has to improve and adapt. The studies will help identify successful strategies for combining material efficiency with architectural creativity.

Research by Design

Using parametric design tools (e.g., Grasshopper for Rhino), this phase will focus on developing digital models that explore timber's natural properties—such as flexibility and grain—to create expressive, non-rectilinear tectonic systems. These design explorations will emphasize adaptability to local Dutch constraints, aiming to devise forms that optimize timber's potential while minimizing waste. The outcome will be a set of digital prototypes that showcase how parametric tools can reshape traditional timber tectonics and adapt to local ecological needs.

Prototyping/Testing

To test the feasibility of these digital designs, prototyping will be conducted by for example using CNC milling. Physical prototypes will be developed to assess the structural integrity, aesthetic quality, and practical applicability of the proposed tectonic systems. This phase will offer concrete data on how digital fabrication can support both the expressive and functional aspects of timber construction, particularly within the limitations posed by local forestry resources in the Netherlands.

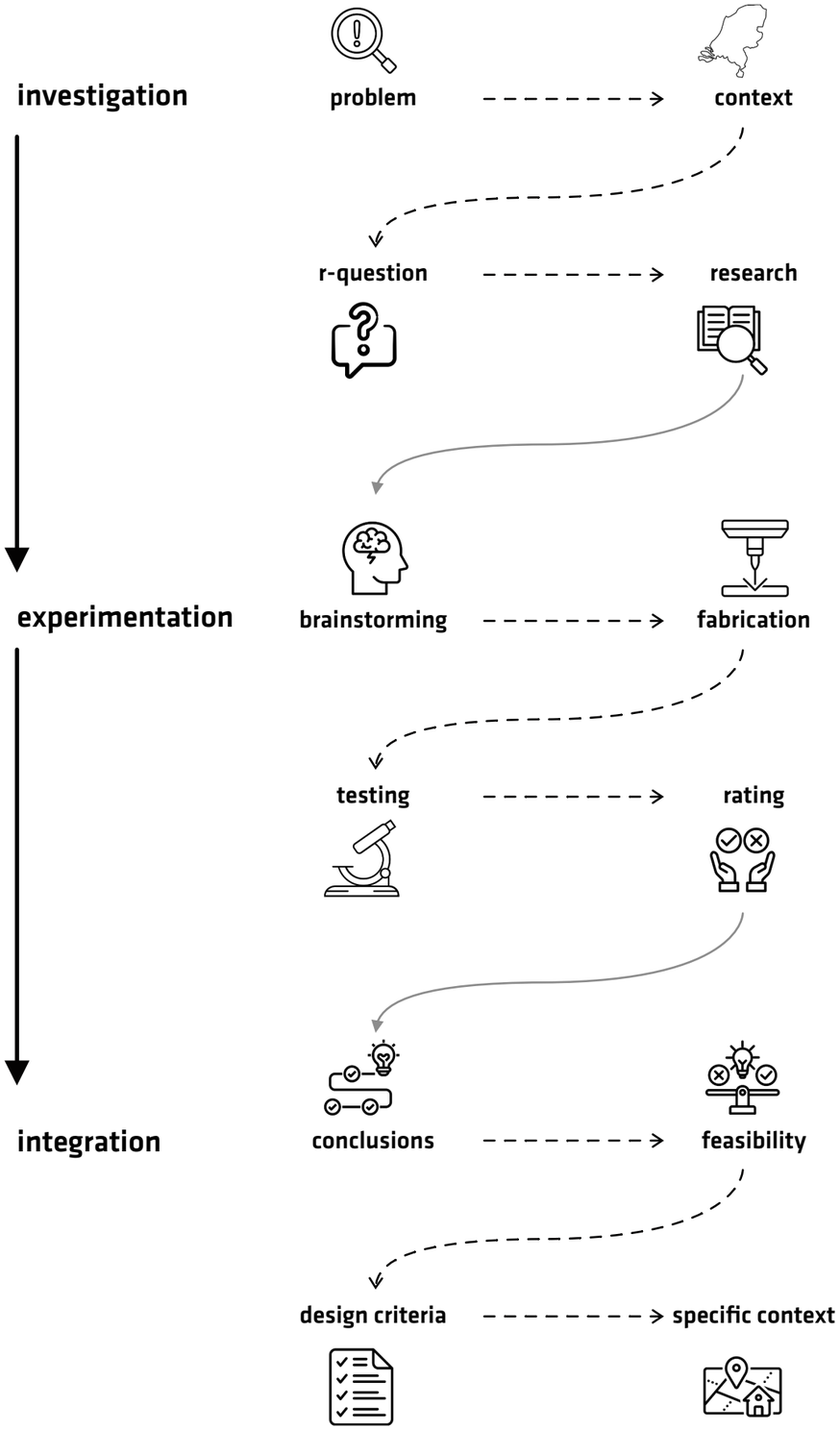
Lifecycle Analysis

A lifecycle analysis will be conducted to examine the current timber lifecycle in the Netherlands and identify areas for improvement in terms of sustainability and circularity. This phase will explore how timber can be sustainably sourced, processed, and eventually disassembled and reused, proposing adaptations necessary to establish a local circular wood cycle. The analysis will assess how the reimagined lifecycle can address Dutch urban constraints, reduce waste, and foster sustainable building practices.

Architectural Design Proposal

The culmination of this research will be an architectural proposal for a Timber Hub or School, designed to demonstrate a locally adapted timber lifecycle and tectonic system. This design proposal will integrate findings from the previous phases, applying them to a functional and educational space that promotes timber as a sustainable material within the Dutch context. While the research covers a broad scope, the design proposal will focus on one or two key aspects identified as most critical through the study, ensuring feasibility within the project's timeline. This targeted approach will provide a clear, actionable example of how innovative timber tectonics and a circular wood cycle can transform Dutch architecture.

The aim of this thesis is to gather and synthesize knowledge from diverse sources, connecting insights that often remain fragmented, and adapting them to the Dutch context. Emphasis is placed on learning from Germany, Austria, and Switzerland, where well-established, circular timber principles are advancing toward a sustainable future. By drawing from these countries' practices, this research seeks to apply proven strategies and adapt them to the unique environmental and urban conditions of the Netherlands.



expected outcome

The outcome of this research is to develop a new tectonic language for timber construction that utilizes digital tools to unlock timber's full expressive potential. Moving beyond conventional approaches that mimic concrete or steel, this study aims to define a dynamic use of timber, where its natural qualities, like flexibility, grain, and texture, guide innovative architectural solutions. This goal is particularly relevant within the Dutch context, where limited forestry resources and dense urban environments require a uniquely local and sustainable approach. To support this, the research will propose a circular lifecycle for timber, from responsible sourcing to material processing and disassembly.

Recognizing the project's scale, the design proposal in the P3 phase will focus on one or two key findings from the research. This targeted approach will allow for a practical, feasible demonstration of how innovative timber tectonics can be applied in a Dutch setting.

The research may conclude with a framework for implementing a closed-loop timber system in the Netherlands, optimized for local resources and constraints. The final design proposal should take place in a typical dense , urban context. The architecture exemplifies the new tectonic language—integrating advanced fabrication techniques and sustainable wood practices to showcase timber's architectural versatility and ecological benefits. This structure would serve as a case study, demonstrating the potential for a Dutch-specific timber approach.

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