Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Aron Arend Bakker
Student number	5658004

Studio		
Name / Theme	BT Graduation Studio	
Main mentor	Mauro Overend	SD
Second mentor	Paul de Ruiter	DI
Argumentation of choice of the studio	SD (structural design) for the focus on using reclaimed structural elements and creating joints, and DI (design informatics) for the atomization and digital fabrication of the joints	

Graduation project	
Title of the graduation project	Hybrid structures with reclaimed wood by utilizing 3D printed joints
Goal	
Location:	Not needed
The posed problem,	Construction materials in the building industry are responsible for a large share of total carbon emissions contributing to climate change. While wood presents a more sustainable option, its production falls short of meeting the escalating demand for construction materials in the building industry. To augment the utilization of wood as a construction material, there is a need to address waste management issues and enhance the reuse of wooden structural elements. Nevertheless, the reuse of these elements introduces complexities in design, with a fluctuating stock that requires adapting to varying optimal geometries and complex joints. The extended design time and heightened energy requirements pose obstacles to

	the widespread adoption of wooden structural element reuse.
research questions and	The following research question is attempted to be answered: Can stock-constrained digital design combined with 3D printing as a digital fabrication method overcome the challenges faced by the building industry to reuse wooden structural elements without saw-off losses? This leads to the following sub questions: - What are the primary obstacles faced by designers in the process of reusing wooden structural elements? -What prevents stock-constrained design tools from improving the reuse of wooden structural elements in the current environment? -Can a rationalized connection between stock-constrained design and additive manufacturing of the structural joints streamline the development of projects? -How should this connection work in order to produce functional joints?
design assignment in which these result.	Objectives: -Create an alternative stock-constraint design tool that enables the extraction of essential information to further develop the joint -The development of a topology optimization that can generate joints with the given requirements from design and additive manufacturing method -a streamlined workflow that optimizes a structural design towards a minimal footprint and maximum future reuse to manufacturing of the structure

Process

Method description

Literature review
A comprehensive literature review will be conducted, delving into key topics:

- Stock-constrained design

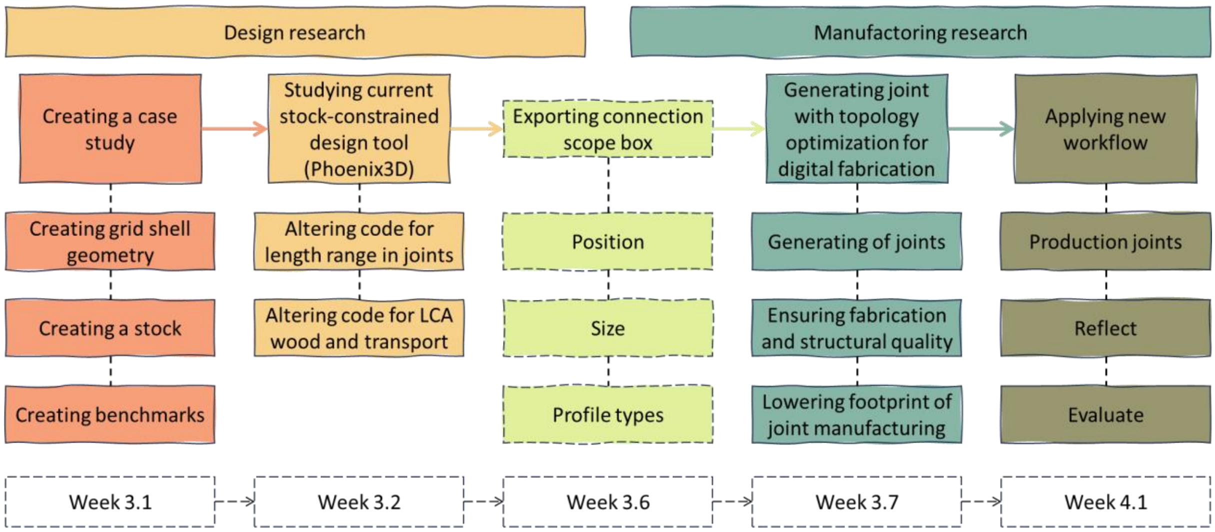
- 3D printing
- Topology optimization
- Reuse of wooden structural elements

Case study: Modelling halls roof faculty of architecture TU Delft

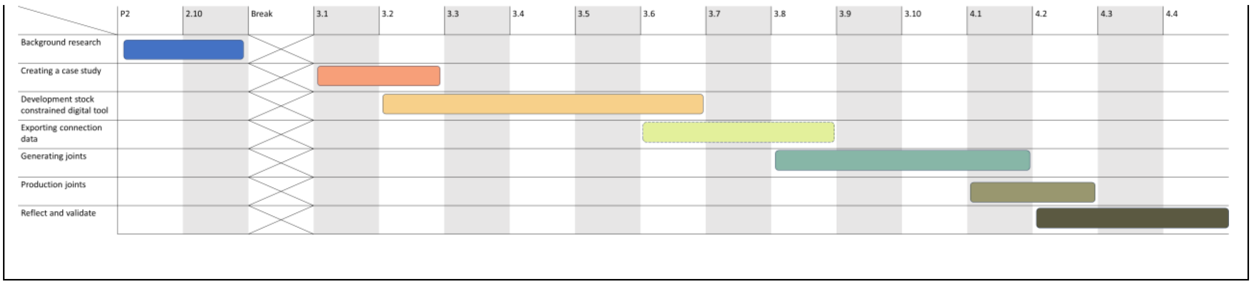
As a case study the roof of the modelling hall of the architecture faculty of TU Delft has been chosen. This further constrains the study at first by giving it a real-life example, and postponing the study in order to investigate its potential in scalability. With the real-life example it becomes possible to benchmark the different scenarios against each other:

- The current situation
- Situation new out of new timber
- Situation new out of a combination of used and new timber with current stock constrained design
- Situation new with newly developed workflow

Design and manufacturing research



By designing and developing the proposed workflow it becomes possible to gather information about its functionality along the way. Every step forms an opportunity to validate the work from before by working with the created pieces of workflow. It will start with working on the stock-constrained design tool. With the created benchmark a feedback loop is created to see if the alterations have any effect or not. Once the desired changes have been achieved it goes to data extraction that is necessary for creating the joints. This process will form the bridge between the stock-constrained design tool and the generating of the joints since this step is responsible for the communication between the two. At the generating of the joints themselves the focus will turn to ensure functionality while minimizing the total footprint. Finally, the complete workflow will be tested and reflected on by physical and digital testing.


P2
2.10
Break
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
3.10
4.1
4.2
4.3
4.4
Background research
Creating a case study
Development stock constrained digital tool
Exporting connection data
Generating joints
Production joints
Reflect and validate

Literature and general practical references

Added to this document is a reference list of sources that have been used for the background information.

Reflection

1. This graduation topic aligns seamlessly with the BT master track, intertwining research on sustainability to achieve optimal structural element footprints and the development of digital tools that blend structures with design informatics. Additionally, it leverages the potential of digital fabrication through 3D printing.
2. The significance of this research emerges from the underutilized potential of reusing wooden structural elements within the building industry. Despite its ability to significantly reduce the industry's carbon footprint, these elements often miss a second service life due to the perceived complexities in design and manufacturing. Existing tools address these challenges individually, yet a cohesive, streamlined process from design to manufacturing remains elusive. By bridging this knowledge gap, this study aims to simplify the reuse of wooden structural elements.

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