

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	Frank de Zwart
Student number	4860683

Studio		
Name / Theme	Structural & Computational design	
Main mentor	Stijn Brancart	Structural Design
Second mentor	Gabriele Mira	Computational design
Argumentation of choice of the studio	Two different 'colours' of specializations are required for the studio; and my interest lie in structural design and the way I want to approach this is through computational modeling.	

Graduation project	
Title of the graduation project	Y.U.S.F.-Your Urban Structural Forestry Reallocating unwanted trees to loadbearing structures.

Goal	
Location:	Delft/Rotterdam
The posed problem,	Hardwood trees in Rotterdam are being cut down because they are unwanted, sick or pose safety risks. However, due to the lack of a workflow and sufficient resources, these trees are rarely repurposed optimally for timber products. This is particularly unfortunate given the high demand for timber. Especially since hardwood species can take a long time to grow, and most of them have great structural properties. Using timber in the build environment is a great way to reduce the CO2 footprint of a building since the wood serves as a storage for CO2. We need more environmentally building practices to reach the Paris Agreement climate goals. By reframing the utilization of Rotterdam's stray wood there is benefit

	to be made in the carbon emissions of local building practices.
research questions and	How can a framework be designed to repurpose trees marked for removal into structural skeletons, using Rotterdam's urban forestry as a case study?
design assignment in which these result.	A computer program that creates loadbearing structures on demand from trees that are going to be cut in Rotterdam; reallocating the trees before they're taken down.

Process

Method description

There will be literature reviews to get a better understanding of timber and its structural use in buildings. For the case study of Rotterdam's trees there will be interviews conducted with parties involved around the repurposing their city trees. As for a proposal of the computational workflow, a prototype will be made combining python with data provided by the GIS software from the municipality and structural approximations using software like Ansys or Karamba.

Literature and general practical references

Brütting, J., De Wolf, C., & Fivet, C. (2019). The reuse of load-bearing components. IOP Conference Series Earth and Environmental Science, 225, 012025. <https://doi.org/10.1088/1755-1315/225/1/012025>

Brütting, J., Senatore, G., & Fivet, C. (2021). Design and fabrication of a reusable kit of parts for diverse structures. Automation in Construction, 125, 103614. <https://doi.org/10.1016/j.autcon.2021.103614>

Dickson, M., & Parker, D. (2014). Sustainable timber design. In Routledge eBooks. <https://doi.org/10.4324/9781315774114>

Küpfer, C., Bertola, N., Brütting, J., & Fivet, C. (2021). Decision framework to balance environmental, technical, logistical, and economic criteria when designing structures with reused components. Frontiers in Sustainability, 2. <https://doi.org/10.3389/frsus.2021.689877>

Marriage, G. (2024). Timber: trees and wood in construction. In *Elsevier eBooks* (pp. 127–147). <https://doi.org/10.1016/b978-0-323-98336-5.00007-8>

Ramage, M. H., Burrige, H., Busse-Wicher, M., Fereday, G., Reynolds, T., Shah, D. U., Wu, G., Yu, L., Fleming, P., Densley-Tingley, D., Allwood, J., Dupree, P., Linden, P., & Scherman, O. (2016). The wood from the trees: The use of timber in construction. Renewable and Sustainable Energy Reviews, 68, 333–359. <https://doi.org/10.1016/j.rser.2016.09.107>

Timbolmas, C., Bravo, R., Rescalvo, F. J., Ringhofer, A., Sieder, R., & Lorenzana, J. (2024). Experimental study of hybrid pine-birch glued-laminated timber beams assisted by digital image correlation technique. European Journal of Wood and Wood Products, 82(4), 1187–1199. <https://doi.org/10.1007/s00107-024-02063-5>

Wang, Q., Wang, Z., Feng, X., Zhao, Y., & Li, Z. (2024). Mechanical properties and probabilistic models of wood and engineered wood products: a review of green construction materials. *Case Studies in Construction Materials*, e03796. <https://doi.org/10.1016/j.cscm.2024.e03796>

Fraanje, P. (1999). Natuurlijk bouwen met hout: 33 boomsoorten die zich thuisvoelen in Nederland en België. Jan van Arkel, pp. 448.

Merz, K., Niemann, A., Torno, S. (2021). Building with hardwood. DETAIL, Birkhäuser, pp. 112.

Swedish Wood. (2015). *Design of timber structures: Volume 1: Structural aspects of timber construction* (3rd revised ed.).

<https://www.houtinfo.nl/>

<https://www.houtinfobois.be/nl/>

<https://www.matweb.com/>

Reflection

1. What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS)?

My graduation topic combines structural and computational knowledge in the build environment. A better understanding of structural physics and gaining computational skills are some key learning objectives in the master track BT. The overall master programme MSc AUBS is aimed to deliver engineers with a speciality in the build environment and affinity with environmentally friendly design. All these topics are checked in the graduation topic.

2. What is the relevance of your graduation work in the larger social, professional and scientific framework.

The graduation work tackles a current inefficiency in material usage and plans to offer a solution that benefits the housing market, the environment and local economics. Professionally, the graduation will expand my skillset, strengthens my knowledge and shows a devotion to the topics I would like to specialize in. From a scientific perspective, this work has the potential to serve as a foundation for further research, providing my peers with a valuable starting point and paving the way for the development of more comprehensive and effective frameworks in the future.