RESEARCH PLAN TEMPLATE

Architectural Engineering Graduation Studio

The research plan is a document which structures your graduation in an academic way. The research plan is built up of two sections. The first section describes the general problem statement and the overall design objective and the second section covers the definition of the related (technical) thematic research. The research plan is delivered at the P1 and focusses on the set up of the thematic research and explains how the chosen research theme is related to the overall design question / objective. The research plan describes as well how you aim to use the knowledge and insights of your thematic research within your overall design approach.

The second part of the research plan, focusing on the thematic research, forms the base for your thematic research paper which needs to be delivered two weeks before the P2. For more information about deadlines and deliverables see Brightspace.

Research Plan Structure

1) Written research plan of ± 2.000 to 2.500 words (the more concise, the better).
2) Visual translation of the research plan into a diagram (A4 portrait).

Content Research Plan

Personal Information

Name:	Tjeerd J. Prins
Student number:	5254485
Address:	Balthasar van der Polweg 890
Postal code:	2628ZJ
Place of residence:	Delft
Telephone number:	+31 6 25531429

Studio

Name of studio:	Architectural Engineering	
Design tutor:	Stephan Verkuijlen	<S.H.Verkuijlen@tudelft.nl>
Research tutor:	Mo Smit	<M.J.Smit@tudelft.nl>

Argumentations of choice of the studio:
I have chosen Architectural Engineering, because I find it important to design with material construction and climatic aspects as a guide. Engineering should not be a means to an end, solving the issues that arise in an unrealistic architectural approach, only founded in artistic quality. Engineering should be a starting point. Additionally, this studio allows the most freedom to explore my own fascination.

Title of Graduation Project

Growing Indigenous Architecture

Transforming Dutch farms into indigenous wood production hubs

Keywords
Wood construction, wood production, forestry, indigenous forests, high-grade application

General Problem Statement

A contemporary challenge in architecture is the desire to limit the carbon footprint of the built environment. Wood construction can play a role in this endeavor by sequestering carbon and substituting unsustainable material use. Emissions in the Dutch building sector can be reduced significantly by shifting existing wood production towards more high-grade applications and upscaling local production (Oldenburger, et al., 2020). Sadly, these aspirations are hindered by the unilateral standardization of wood construction.

Common wood construction methods are limited to coniferous wood products. Local coniferous forestry in the Netherlands has led to undesirable side-effects due to the poor resilience of introduced and exotic tree species in the face of climatic extremes. This lack of resilience leads to degrading ecological networks, susceptibility to calamities and low quality produce (Sauren, et al., 2020; Van Kemenade, et al., 2021, Staatsbosbeheer, 2022). Annual reports of Staatsbosbeheer (2020; 2023; 2024) and Stichting Probos et al., (2022; 2023; 2024) show a 35% decline in wood production since 2016, which is attributed to calamities such as drought and disease.

Due to local quality, only 28,6% of Dutch wood finds a high-grade application in construction (Probos, n.d.). The remaining volume is used in products with a limited lifespan. For example, 80% of hardwood is used as firewood and only 13% is used for construction. The Netherlands lags behind the EU in this matter (Oldenburger, et al., 2020). There is still much to be gained in terms of high-value application, cascading and exploring the potential of local wood types in construction.

To conclude, the standardization of wood construction methods on introduced softwood species has led to undesirable side-effects, such as degrading nature, declining production, and low-value wood chain. These problems must be overcome in order for wood construction to efficiently contribute to emission reduction in the Dutch building sector.

Overall Design Objective, Question & Hypothesis

After termination of a livestock farm through the voluntary buy-out policy for peak polluters (Overheid.nl, 2024), the land is not always given a new destination immediately and the buildings are often demolished (Klomp, 2022). This moment of uncertainty is posed as an opportunity to overcome land scarcity; an argument that can be held against production forestry (Searchinger, et al., 2023).

The objective of the Overall Design Assignment is to find a generic method to repurpose and transform this bought-out farm real estate into sustainable indigenous production forests with a complementary program, including suitable production facilities as well as recreational and ecological services. This project limits itself to the province Gelderland and its landscape, due to the 60,1% share of peak polluter candidates and the proximity of the most vulnerable natural environment in the Netherlands, the Veluwe (RIVM, et al., 2023).

Flexibility in the program is an important aspect, as the use of production forests fluctuates throughout the decades (Klingen, 2022). Additionally, the outcome of the Thematic Research will determine the building system strategies and specify the program of the design, as they will be inspired by the properties of and possibilities with indigenous wood species.
The design question is formulated so that the context, program and thematic focus are clear:

How can bought-out farm real estate in Gelderland be repurposed as indigenous production forest hubs with building systems adapted to indigenous wood species?

This design assignment is expected to introduce a new typology, where the material construction industry, recreation and ecology are not seen as mutually exclusive to the general public, but rather as a visible functioning collaboration (ecosystem). This would create strong arguments in favor of local production forestry, as spatial, financial limitations and stigma can be overcome.

Reflection on the Relevance

Combining the problems of the current wood chain with land acquisition through the termination policy of livestock farms is an opportunity that only presents itself this decade (Overheid.nl, 2024). A generic design strategy would help to ensure quick implementation, acting against demolition of real estate and providing a function that benefits the building sector, the ecology and the surroundings.
Policy documents of local authorities show interest in pilots and experimentation on former agricultural land, aimed at recreation, improving biodiversity and creating nature-inclusive business models (Regio Stedendriehoek, 2023). Moreover, this intervention contributes to societal challenges including:

- Reduction of the national carbon footprint of material use and transport,
- Providing ecological services, e.g. biodiversity, carbon sequestration, water retention,
- Creating valuable mixed-use public space and proximity to the production chain,

Thematic Research Objective, Question(s) & Hypothesis

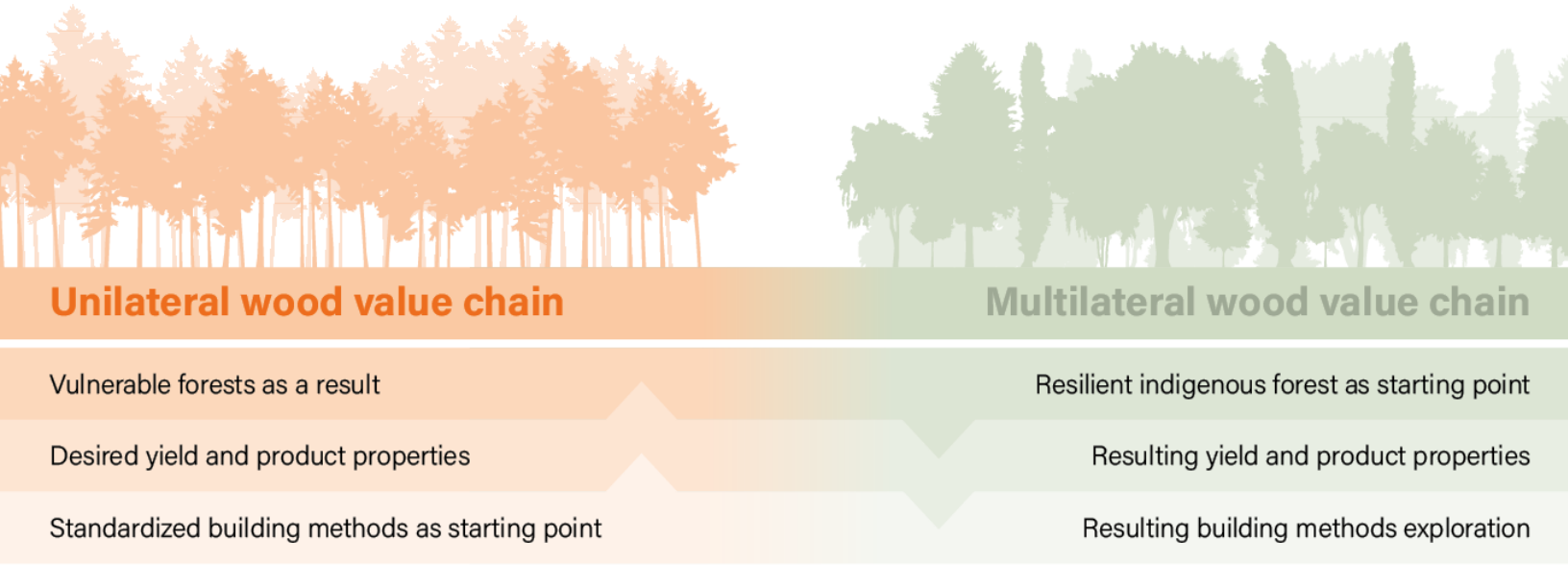
While the demand for wood use in construction is increasing, the wood chain is generally unilateral, aimed at standardized construction methods of softwood species. In the Netherlands, this led to low-grade end use and practices that result in declining yield and degradation of indigenous nature.

These flaws in the production chain can be addressed with an integral approach, reinstating resilient indigenous forests from which we can extract materials for application in building systems. Research is required to assess the potential of this approach; especially the potential of local wood species in construction. This leads to the following question:

How can we reinvent wood construction as a multilateral practice, adapted to the properties of indigenous wood species in the Netherlands?

In order to structure this research, the question is segmented into three sub-questions, each related to one of the problems that were addressed in the problem statement. The questions are specified to the context of the overall design assignment.

1. What would be the ideal composition of an indigenous forest in Gelderland, considering species, spatial distribution and landscape qualities?
2. What are the characteristics of such an indigenous forest in terms of yield and product properties?
3. How can these characteristics efficiently relate to tectonics, focusing on mechanical properties in relation to placement, and harvest rotation in relation to the value chain?



Firstly, the objective is to create a sustainable and indigenous prototype forestry system) for the project location (De Stedendriehoek, Gelderland). The possible yield will then result in specified programmatic requirements for production facilities in the design, depending on how the various wood species can be processed. Lastly, the research aims to contribute a set of principles towards new tectonics for wood architecture. These tectonics will be based on a 'ecosystem to building system'-approach, rather than the current method of adapting the type of production to the desired end-use product.

Reflection on the relevance

This thematic research is relevant because it adds to the contemporary narrative in which architecture is once again seen as part of the natural environment. There is sufficient research mapping the wood value chain (Mo, Haviarova, & Kitek Kuzman, 2024) and literature, arguing for the use of indigenous wood species in construction (Fraanje, 1999). However, providing new ideas for methods of construction that are currently based on unsustainable systems is a topic that has not yet been extensively explored and detailed.

The preference for local production and substitution of less sustainable building systems should not lead to new problems, such as loss of biodiversity or high supply risks. The rise in popularity of bio-based systems makes this discussion of wood construction even more important. This research can help strengthen the argumentation in favor of production forestry, if the negative side effects of the unilaterally standardized wood value chain can be avoided.

Thematic Research Methodology

The methodology will be structured according to the sub-questions.

Firstly, indigenous tree species of the project location will be inventoried. This qualitative analysis will be based on a literary study. Vegetal scientist and ecologist Eddy Weeda (2013; 2014) for example, bundled original documentation on the last primeval forest in the Netherlands; the Beekbergerwoud. Van Kemenade & Maes (2024) defined a list of endangered shrubs and trees in Gelderland, including recommendations for forest management. Such sources will help to construct a prototype indigenous forest system, specific to the location. This system will be the starting point for the continuation of the research.

Secondly, the quantitative characteristics of this prototype forest system will be determined. The yield will be defined per hectare, depending on the growth time and harvesting techniques. The properties of the resulting products will be retrieved from a reliable database. This data will be categorized and visualized for easy comparison, which is required to determine possible design directions in the third part of the research.

Thirdly, through a process of research by design, the qualities of the wood species will be translated into efficient building systems. The mechanical properties of the wood species must therein be efficiently exploited in the structural function they fulfill. The temporal properties, such as the growth time and harvest rotation, must be taken into account in possible cascading solutions for the value chain. This last step can be further underpinned by case study research into vernacular wood architecture.

Although this last phase will end with a conclusion, answering the question of how to adapt building systems to indigenous wood species, the process of research and design will likely continue in the overall design assignment of this graduation project.

Expected results of thematic research and design implementation

The contribution of the thematic research to the overall design assignment is threefold:

Firstly, introducing local production forestry as a new destination for bought-out farmland was the driving force behind the overall design assignment. The prototype forest system that results from answering sub-question one is therefore an important part of the graduation project. Secondly, the research will give insight into the possibilities for production and the processing of indigenous wood species, which will help to clarify specific programmatic requirements for the design, given the aim of combining the production site with its associated industrial facilities. Thirdly and most importantly, the overall design assignment will be used to test, and potentially further develop, the adapted indigenous wood construction systems that result from the thematic research.

It is difficult to quantify the success of the outcome of this project without actually realizing it. The project is however expected to encourage new tectonics for wood construction and a new typology which brings the general public closer to the production chain. A less unilateral and more species-specific approach to wood construction will be a valuable addition to the narrative of biobased building, the energy transition, and nature preservation.

Literature references

Fraanje, P. (1999). Meer hout in de bouw. *Nederlands Bosbouw Tijdschrift*, *6*, 237-241.

Klingen, S. (2022). *HOUTFABRIEK - 21 Misverstanden over bos en bomen* [Online]. Klingen Bomen. https://houtfabriek.nl/

Klomp. S. (2022). *Wat gebeurt er als een boerderij wordt opgekocht? 10 vragen en antwoorden*. RTV Drenthe. https://www.rtvdrenthe.nl/nieuws/14965121/wat-gebeurt-er-als-een-boerderij-wordt-opgekocht-10-vragen-en-antwoorden

Mo, J., Haviarova, E., & Kitek Kuzman, M. (2024). Wood-products value-chain mapping. *Wood Material Science & Engineering*, *19*(4), 955–965. https://doi.org/10.1080/17480272.2024.2328787

Oldenburger, J., Reichgelt, A., Boosten, M., Penninkhof, J., Teeuwen, S., Kremers, J., & Van Benthem, M. (2020). Meer hoogwaardig gebruik van Nederlands hout. *Stichting Probos*.

Overheid.nl. (2024). *Landelijke beëindigingsregeling veehouderijlocaties met piekbelasting*. Overheid.nl Wettenbank. https://wetten.overheid.nl/BWBR0048262/2024-04-16

Probos. (n.d.). *Bos en Hout Cijfers*. Bos en Hout Cijfers. https://www.bosenhoutcijfers.nl/

Regio Stedendriehoek. (2023). Uitvoeringsagenda 2023-2030. In *Uitvoeringsagenda Regio Stedendriehoek*. https://regiostedendriehoek.nl/kennisbank/uitvoeringsagenda-regio-stedendriehoek-2023-2030/

RIVM, Van Der Maas, C. W. M., Jones, P. A., & Hazelhorst, S. B. (2023). *Bepalen drempelwaarde piekbelasters-aanpak*. Rijksinstituut voor Volksgezondheid en Milieu. https://doi.org/10.21945/RIVM-2023-0313

Sauren, P., Buysse, W., Wijdeven, S., Seynaeve, J., Winnock, M., Van Nevel, L., & Nyssen, B. (2020). Ecologie in Boomgericht Bosbeheer. *Eco2eco*.

Searchinger, T., Peng, L., Zionts, J., & Waite, R. (2023). The Global Land Squeeze: Managing the Growing Competition for Land. In *World Resources Institute*. World Resources Institute. https://doi.org/10.46830/wrirpt.20.00042

Staatsbosbeheer. (2020). *Jaarverslag 2019*. https://www.rijksoverheid.nl/documenten/rapporten/2020/05/01/jaarverslag-2019-staatsbosbeheer

Staatsbosbeheer. (2022). *Het Nederlandse bos wordt steeds gevarieerder*. https://www.staatsbosbeheer.nl/wat-we-doen/nieuws/2022/07/7e-bosinventarisatie

Staatsbosbeheer. (2023). *Kiezen en Delen | Jaarverslag 2022*. https://www.rijksoverheid.nl/documenten/rapporten/2023/10/24/jaarverslag-2022-staatsbosbeheer

Staatsbosbeheer. (2024). *Startpagina Staatsbosbeheer. Het zit in onze natuur*. https://www.staatsbosbeheer.nl/

Stichting Probos., Oldenburger, J., Teeuwen, S., & Van Best, S. (2022). *Houtproductie en -gebruik in Nederland Productie, import, export en consumptie van houtproducten in 2020*. Stichting Probos. https://www.probos.nl/publicaties/rapporten/rapporten-2022/1759-houtproductie-en-gebruik-in-nederland-in-2020

Stichting Probos., Oldenburger, J., Teeuwen, S., Beerkens, G., Op den Kelder, G., & Van Maaren, G. (2023). *Houtproductie en -gebruik in Nederland Productie, import, export en consumptie van houtproducten in 2021*. Stichting Probos. https://www.probos.nl/publicaties/rapporten/rapporten-2023/1880-houtproductie-en-gebruik-in-nederland-in-2021

Stichting Probos., Teeuwen, S., Op den Kelder, G., Van Maaren, G., & Velthuis, J., (2024). *Houtproductie en -gebruik in Nederland Productie, import, export en consumptie van houtproducten in 2022*. Stichting Probos. https://www.probos.nl/publicaties/rapporten/163-rapporten-2024/1967-houtproductie-en-gebruik-in-nederland-in-2022

Van Kemenade, L., Maes, B., Copini, P., & Brinkkemper, O. (2021). Behoud genenbronnen van autochtone bomen en struiken in de Bossenstrategie. *Vakblad Natuur Bos Landschap*, *18*(172), 37–40. https://research.wur.nl/en/publications/behoud-genenbronnen-van-autochtone-bomen-en-struiken-in-de-bossen

Van Kemenade, L., & Maes, B. (2024). *Attentielijst bedreigde wilde bomen en struiken - Gelderland*. Rijksdienst Voor het Cultureel Erfgoed. https://kennis.cultureelerfgoed.nl/index.php/Attentielijst_bedreigde_wilde_bomen_en_struiken_-_Gelderland

Weeda, E. J. (2013). Productie-oerwoud op z'n negentiende-eeuws. I. Mensen, planten en dieren in en om het Beekbergerwoud. *Stratiotes*, *45*, 29-50.

Weeda, E. J. (2014). Productie-oerwoud op z'n negentiende-eeuws. II. Plantenvondsten en vegetatie-elementen in en om het Beekbergerwoud. *Stratiotes*, *46*, 57-85.

Planning (for the student as guiding tool)

MSc 3	Q1	Week 1.1-1.9: Week 1.10:	Completed Research plan & presentation (P1)
	Q2	Week 2.1-2.3: Week 2.4-2.5: Week 2.6-2.8: Week 2.8: Week 2.9: Week 2.10:	Sub-question 1 Sub-question 2 Sub-question 3 Graduation plan (P2-a) GO/NO-GO Finalization of thematic research paper Thematic research paper & presentation (P2-b) GO/NO-GO
MSc 4	Q3	Week 3.1-3.3: Week 3.4-3.6: Week 3.6: Week 3.7/3.8/3.9:	Analysis, sketching Preliminary design Register for P4 Poster presentation of design progress (P3)
	Q4	Week 4.1-4.3: Week 4.4: Week 4.5: Week 4.6-4.9: Week 4.10:	Finalization of overall design assignment Reflection, graduation plan, updated thematic research paper Poster presentation of design progress (P4) GO/NO-GO Preparing for P5 Final presentation (P5)

VISUALIZATION

Problem: Unilateral wood value chain	Research: Multilateral wood value chain
Vulnerable forests as a result	Resilient indigenous forest as starting point
Desired yield and product properties	Resulting yield and product properties
Standardized building methods as starting point	Resulting building methods exploration

Design: The indigenous production forest hub