Reflection

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Studio / Theme	Architectural Engineering Studio / Harvest
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Graduation project topic

Integrating end-of-life wind turbine blades into a variety of building layers through multiple use cycles – a strategy to maximize the lifetime of wasted materials; a case study in Eemshaven.

1. What is the relation between your graduation project topic, your master track (Ar, Ur, BT, LA, MBE), and your master programme (MSc AUBS)?

Repurposing end-of-life (EoL) wind turbine blades (WTB) as building materials offers a potential solution to address the significant waste volume associated with this material in the market, aligning with the focus on circularity in the Architectural Engineering (aE) studio.

The building in that sense, asides from the cultural and social roles, will serve as a material bank, storing waste materials and postponing their EoL. Designing a building or its components, such as structures or facades, using WTB poses various technical experiments, which have been effectively supported through the expertise and network of the aE studio.

Another aspect that facilitates postponing EoL is designing for multiple-use cycles, which is a prerequisite for successful structural reuse in design (Joustra et al., 2021). This approach promotes designing for disassembling the building product made of WTB, to enable the reuse or repurposing of them in the next lifecycle(s).

Integrating WTB as new construction materials in buildings not only introduces new technical challenges but also enriches the architectural culture, a well-established value within the Architecture master track and program. This exploration expands the horizons of architectural possibilities beyond conventional options such as steel or timber.

2. How did your research influence your design/recommendations and how did the design/recommendations influence your research?

The research provides crucial data on end-of-life wind turbine blades (WTB) and community needs to support the design process. Its objective is to integrate WTB into building components that meet local demands and promote waste utilization in design.

Additionally, the research establishes a conceptual timeline for the second or third life of WTB and identifies suitable integration points within and around wind farms in Groningen based on local authorities' and communities' development plans. This timeline assists in aligning the design process with upcoming building programs and the requirements for multiple use cycles.

The design process offers experimental solutions, such as a rural coworking space constructed from intact WTB, considering community requirements and insights from the wind industry. By designing WTB for its second life without cuts, multiple-use cycles from the research are emphasized.

Furthermore, the design outcomes demonstrate specific quantities of WTB used in a public building and the WTB storage capacity within a 1m2 building area. This enhances the research's conceptual timeline, providing a more comprehensive understanding of the relationship between WTB sizes and quantities with building structures as well as their programmatic implications.

Additional aspects reflecting the research of the design progress are including the value of the location and the local communities in every design phase, such as the dyke, the local businesses, and their agricultural products, etc.

3. How do you assess the value of your way of working (your approach, your used methods, used methodology)?

The research findings demonstrate the valuable contributions of selected methods, including literature reviews, materials flow analysis (MFA), and interviews, towards the exploration of the technical and conceptual lifespan of end-of-life wind turbine blades (WTB) with multiple-use cycles.

To further develop the research, it is recommended to incorporate more detailed information on the technical properties of each end-of-life component. This can be achieved through structural calculations, fatigue analysis, and life cycle analysis. These additional findings will enhance the precision of the WTB timeline by providing detailed data on the technical aspects.

A further potential approach stemming from the WTB timeline can be investigating the relationship between WTB properties and building types. For example, how many WTB which are 40m can be suitable for an industrial building; or how many industrial buildings that can store a certain amount of 40m WTB, etc.

4. How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?

The topic's social value lies in the collaborative development of Eemshaven, integrating local villagers' demands from Oudeschip with business companies' and the Province of Groningen's plans. By aligning timelines for future buildings, facilities, and wind turbine blade decommissioning, multiple stakeholders' benefits are optimized while ensuring environmental sustainability.

The research benefits from the support of diverse experts in the Netherlands, encompassing knowledge from the construction and wind industries. This collaboration enables an effective industrial-scale approach to address the challenge of managing fibre-reinforced polymer (FRP) waste.

Additionally, the topic contributes to establishing a Circular Economy for FRP components through the implementation of repurposing as a key circular strategy for WTB. The adoption of multiple-use cycles within the topic not only addresses the substantial waste volume but also maximizes the materials' lifespan, highlighting its potential in terms of circularity.

5. How do you assess the value of the transferability of your project results?

The transferability of the WTB project results holds two main values: presenting multiple-use cycles as a new method of treating a large volume of waste and showing a potential vision for the development of Eemshaven with its stakeholders in the upcoming years.

If the value of my project is assessed by Chat GPT 4.0, it will be:

The transferability of the WTB project results holds significant value in several aspects.

Firstly, the research findings and design outcomes provide a valuable framework for addressing the issue of EoL WTB waste not only in the specific context of Groningen but also in other regions with wind farms. The conceptual timeline and planning strategy developed in the research can be adapted and applied to different locations, considering the unique characteristics of each area. This transferability allows for the efficient utilization of EoL WTB as building materials in various contexts, contributing to waste reduction and circularity.

Secondly, the design principles and approaches employed in the project, such as designing for multiple-use cycles and utilizing ready-made components, can be transferred to other construction projects involving alternative materials or waste streams. The emphasis on maximizing material lifespan, minimizing cuts or adjustments, and enabling disassembly align with broader sustainable design principles. These transferable design strategies can inspire and inform future projects seeking to repurpose and reuse materials, fostering a more sustainable built environment.

Furthermore, the research outcomes hold value for stakeholders involved in wind energy and the circular economy. The insights gained from the research can inform policymakers, wind farm operators, and local authorities about the potential of integrating EoL WTB into building components. This transferability of knowledge facilitates informed decision-making processes and encourages the adoption of sustainable practices within the wind energy sector.

Overall, the transferability of the WTB project results lies in its potential to inspire and guide similar initiatives in different geographical contexts, provide a foundation for sustainable design practices beyond WTB, and inform stakeholders about the opportunities and benefits of integrating circularity principles into wind energy projects.