

Designing Applications of the carbon-negative material

a bio-based natural fiber composite (NFC)

Background

This project explores the potential market opportunities and applications for a novel bamboo fiber-reinforced composite material using a bio-HDPE matrix. The research, conducted in collaboration with Eve Reverse, focuses on developing a thermoplastic composite with aligned short bamboo fibers to enhance mechanical properties in specific directions, allowing for programmable strength. The goal is to research the desirability of the new carbon-negative bio-based short fiber composites and designing its appropriate application.

Methodology

The project adopts the Material Driven Design (MDD) method, combining experiential characterization studies, mechanical testing, together with prototyping to assess the composite's desirability, feasibility, and viability. From bamboo fiber composite's stiffness and strength testing, and experiential characterization studies, we get insights from mechanical properties result, observation-based experiments, questionnaires, and interviews result to consumers' perceptions and emotional responses to the material. From them we summarize a design vision to help ideate the application possibility.

Design with NFC

Following the vision, with the help of ideation groups, the idea of a ceiling fan blade perfectly fit the vision and the requirement. A blade shape that considers aesthetics, manufacturability, and stiffness reinforcement is designed and 3d molded. Prototyping and functional testing further confirmed the feasibility of using bamboo composite materials. The study validated vacuum bag thermoforming as an effective prototyping method for producing smooth, uniformly thick bamboo composite blades capable of complex curves. The project also explored the feasibility of remanufacturing a multi-layer plate by pile up bamboo composite which demonstrated the potential for producing larger composite structures.

In conclusion, this project created the material characteristics of bio-based bamboo fiber composites, designed a functional and aesthetic product using the insights from the material characterization. It verified the producibility of the concept design by vacuum bag thermoforming the fan blade using multi-layer bamboo composite laminate. I believe this project will be the good example on using MDD method to research on material implementations.

Yanru Mo
Designing Applications of the new carbon-negative material --- a bio-based natural fiber composite
18th Sep 2024
MSc Integrated Product Design

Committee

Company

Chair: Dr. ir. Jelle Joustra
Mentor: Stefano Parisi PhD
Msc. Karel Brans