Compostable Tensile Structure

This interdisciplinary research developed an environmentally sustainable alternative to abandoned temporary structures, such as festival tents, by engineering composites from biodegradable materials.

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Introduction

Aim

To design disposable structures that fit into existing waste streams, with minimal environmental impact.

How

Compostable materials were studied and combined to produce composites for desired properties.

Outcome

A tensile structure, made entirely of compostable materials. Designed to be added into food waste streams for industrial composting, within 120 days it becomes water, CO2 and humus - a nutrient rich soil.

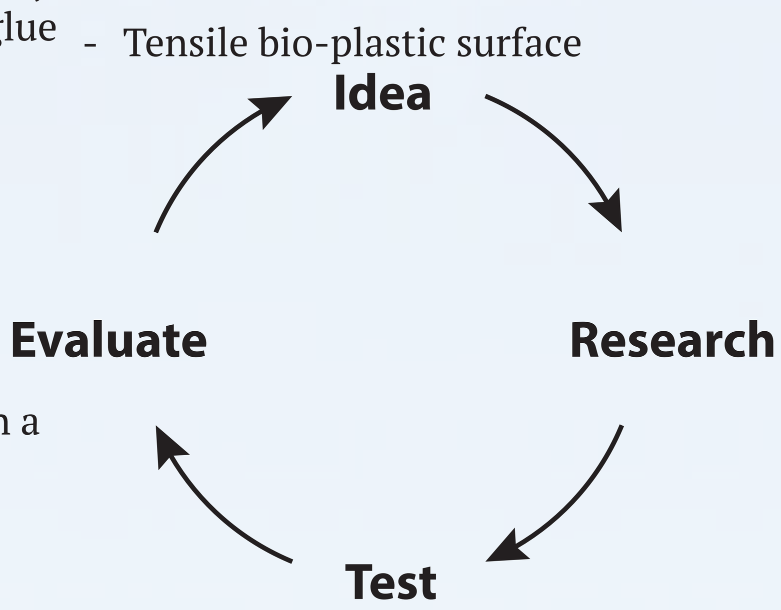
Background

The photograph above illustrates the growing problem of abandoned tents at music festivals across Europe. These tents were not recycled and ended up in landfill. They will take centuries to degrade into tiny fragments, polluting our soil and water systems.

Methodology

1. Ideas generated by personal experiences and influenced by different academic disciplines:

- Cardboard disposable structures
- Bio-plastic surface
- Fibres to improve tensile properties of bio-plastics
- Laminating bio-plastics with an iron
- Tensile bio-plastic surface



2. Researched from different resources:

- YouTube videos on how to make bio-plastics
- Interview with composting sites over the phone
- Searching possible bio-plastics, waterproofing coatings, natural and synthetic fibres
- Discussing with lecturers across faculties for support

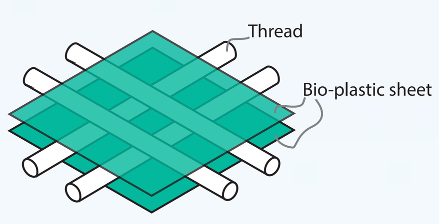
3. Tested using minimal viable products:

- CAD Model
- Model Prototypes
- Checking hydrophobic properties by showering
- Burying samples in compost to check biodegradability
- Making full scale models
- Sleeping in structure

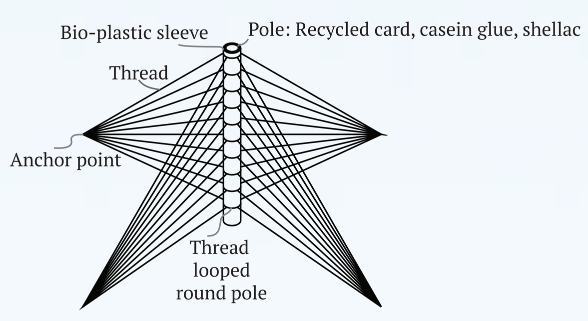
4. Evaluation generated further ideas:

- Shellac (a natural bug secretion) is a compostable waterproofing agent
- Casein glue is hydrophobic and can create strong bonds with paper that do not breakdown when exposed to moisture
- A compostable rigid structure can be made by 6 layers of recycled paper between casein glue and coated with shellac.
- Corn Starch 6 -12 μ Bio-plastic chemical bonds reform at 150-190C, meaning a household iron can be used to create laminates
- Bio-plastic laminated with a natural fibre improves the tensile properties resulting in a biodegradable composite with suitable properties for a tent
- The fibres can be arranged so that tension only occurs along the fibres, minimising the number of fibres, weight and maximising biodegrading time
- Animal hair and bast fibres move between laminated bio-plastic
- Silk has high tensile properties, wicking properties and laminates well
- Corn starch bio-plastic can be made porous by heating between 200-230C.

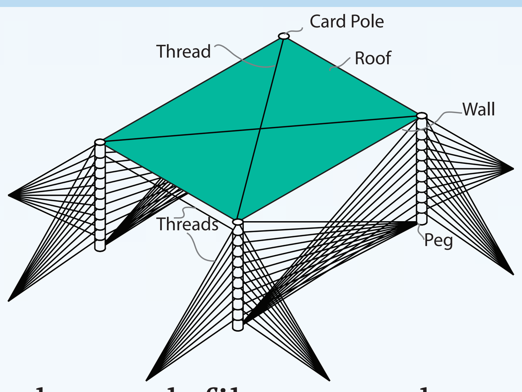
Outcomes



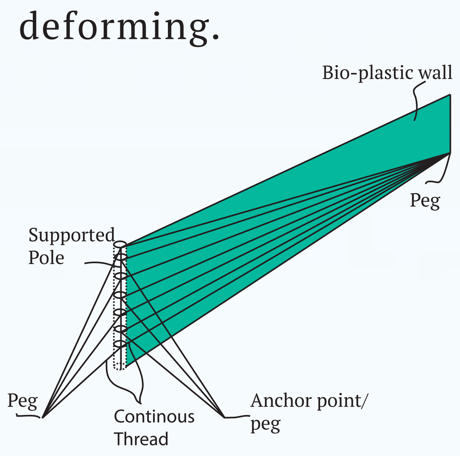
1. Laminating fibres between bio-plastic sheets prevent the entire surface from deforming.



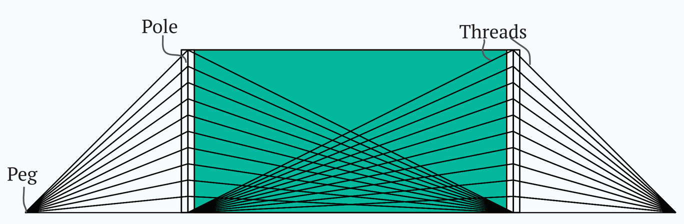
2. A pole can be supported by thin fibres that are anchored in opposite directions. The point of failure is not a local point due to multiple threads and therefore the pole can be thin.



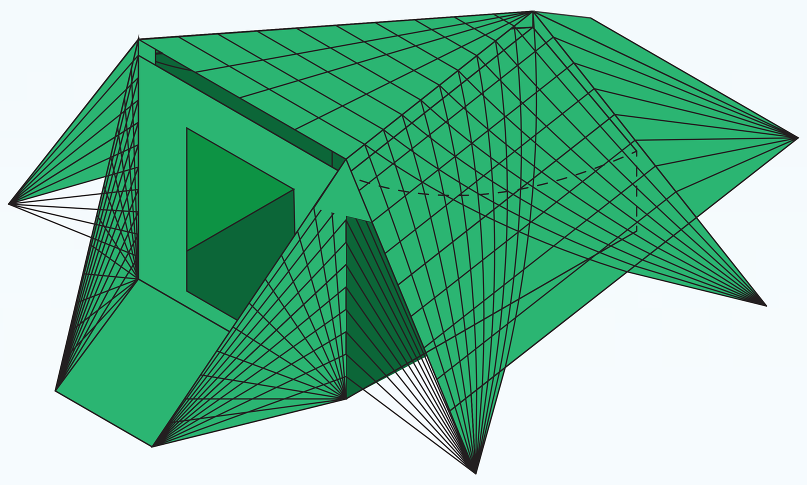
3. The poles and fibres can be arranged to create a simple shelter with an opening and roof.



4. The fibres holding the structure can also stop the bio-plastic from deforming and also create a surface.



5. Fibres are not arranged in a grid, but map out where tension occurs in the fabric or where the pole needs support.

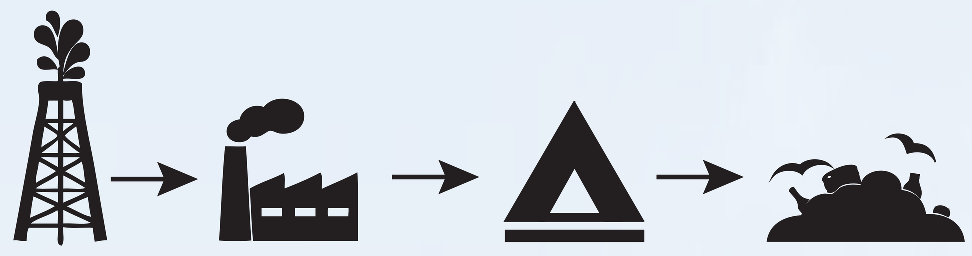


6. Application can take multiple forms. This design considered:
- Double layer for warmth and reduce condensation
- Angled vestibule to direct wind forces
- Sloped roof for rain
- Room to occupy two people

Conclusion

The problem

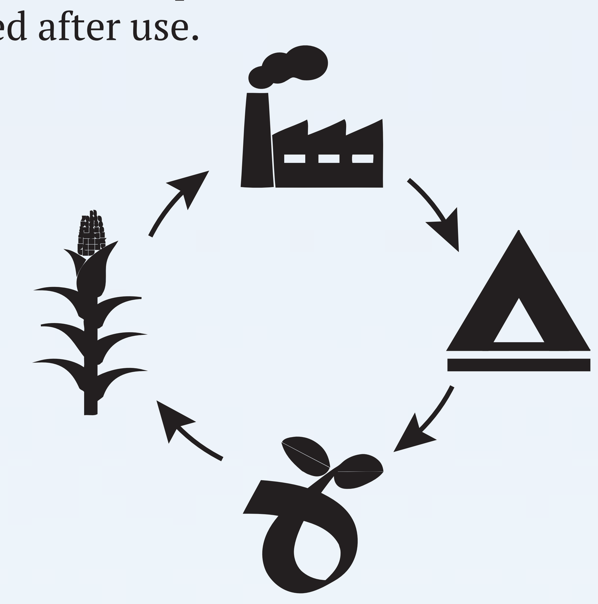
Traditionally products are made with a 'linear' approach where products are designed with little consideration of where they end up. There are many environmental consequences of the 'linear' or 'cradle-to-grave' approach and more research needs to be dedicated towards this field for a wide range of products, not just packaging.



Currently, tents are designed to last and withstand the elements and are so competitively priced that too many have become disposable items, as it is not worth the consumer's time to clean, pack and store them for the following year. Tents are made from many materials with different properties, therefore it is not worth the resources to separate them into their constituent parts for recycling.

The solution

This project used a 'circular design' approach where a product's resources and end of life are key to the design. It is made from plant-based resources and can be composted after use.



Composting is the cheapest form of recycling as the process occurs naturally, meaning little resources are needed to break them down and sorting is not required.

The aim of this project was to design a completely disposable structure that could fit into the European composting waste stream. This excluded many biodegradable materials such as PLA bio-plastics and natural materials, such as wood and fabrics. The project started by testing the potential of waterproofing cardboard and quickly progressed to experimenting with bio-plastics and improving tensile properties with a range of natural fibres as laminate composites.

The project is still on going and has been taken forward as business venture called Comp-A-Tent, with a patent pending on several aspects of the design. Comp-A-Tent's vision is to successfully demonstrate a sustainable economic and environmental business model with this compostable festival tent being the first product offered. This innovation has numerous other applications, such as weekend market stalls, military tents, gazebos and short-term humanitarian shelters.

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