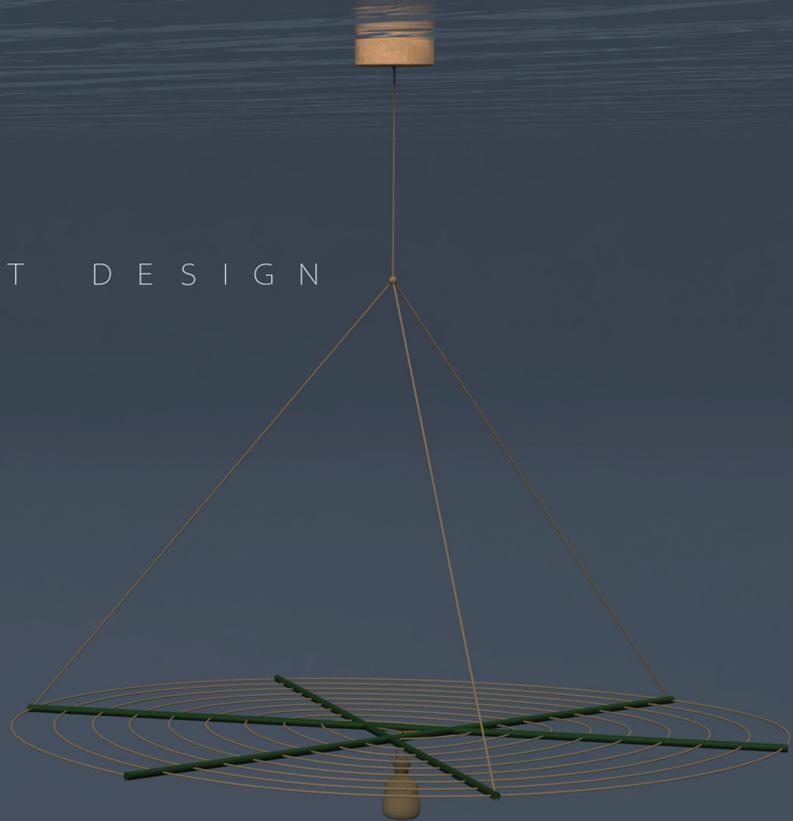




THE SEAWEED SOLUTION

GEMMA BURNSIDE

INDUSTRIAL PRODUCT DESIGN



DETAILS

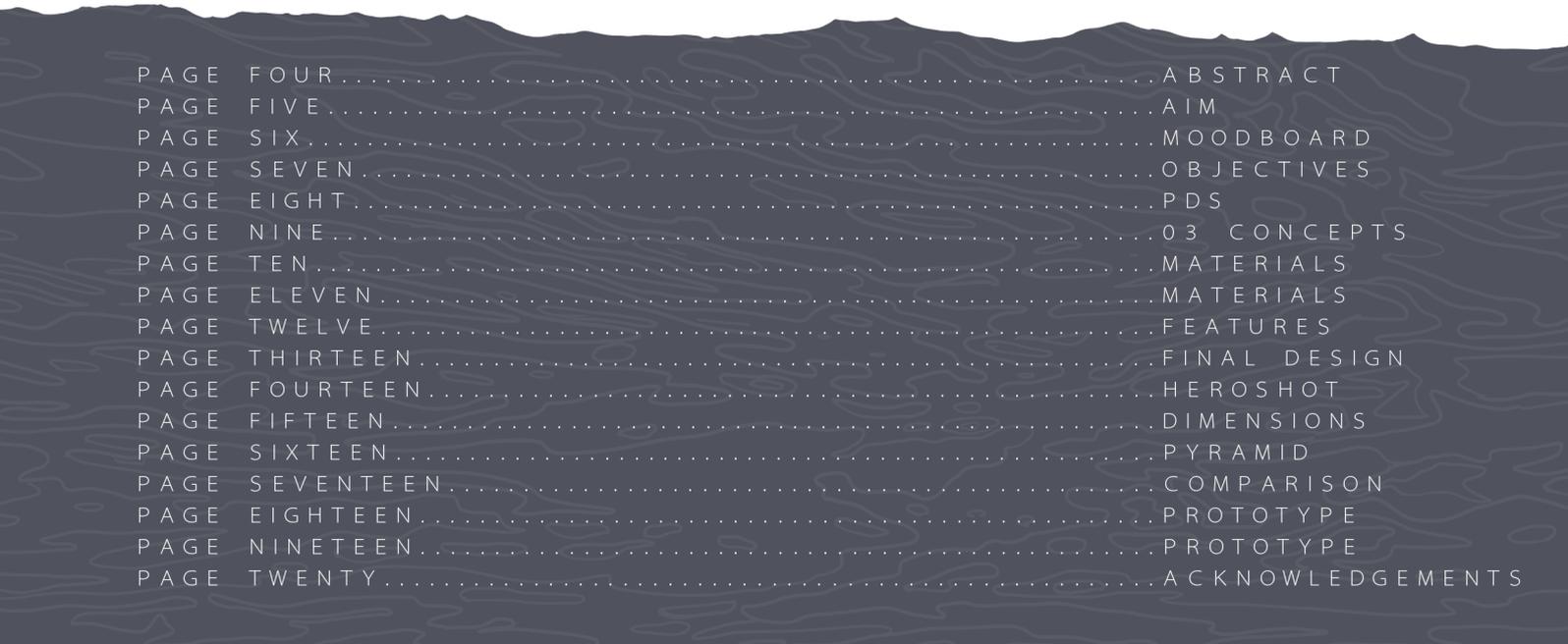
GEMMA BURNSIDE 76453307
INDUSTRIAL PRODUCT DESIGN
PROD314 S2 2020
SUPERVISOR: TIM HUBER
CLIENT: FINN ROSS



PORTFOLIO



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ABSTRACT

I designed an oceanic free-floating biodegradable structure to grow *Macrocystis pyrifera* (giant kelp) as a means of 'carbon farming'. The structure sinks after 150 - 250 days and stores the sequestered carbon at the bottom of the ocean. The structure is designed to facilitate the first 'Blue Carbon' credit in the world and would be the first deep sea aquaculture globally. Ideation, development and refinement design stages were completed to design the structure and buoy, alongside ways for the structure to sink. The structure will sink when a jute rope connection piece from the base structure to the buoy biodegrades in the saline environment. The buoy is to be made from cork due to its high buoyancy, saltwater durability and low environmental impact compared to bioplastics such as PHA/PHB. The base of the structure is to be made from three 4m bamboo poles that are inter-connected through a cross over equilateral triangle (600mm) shape in the centre. This shape was found to be optimal due to area gained against material used as it creates 2.56m² span using three 2m bamboo poles whereas connecting 2m bamboo poles at the ends creates 1.73m² span. Material research and experimentation was completed and hemp rope was found to be optimal in terms of strength, environmental impact and carbon stored. Diagonal lashing connections were found to be the most efficient method of connecting the 60 degree angled bamboo joins. Sand bags were included into the structural design to make the structure negatively weighted whilst storing a small amount of carbon in their hessian material. Overall design decisions were made in regards to overall marine durability, low costing, maximising carbon storage and minimising environmental impact. Feedback from the team of four 4th-year mechanical engineering students (Dominique Poff, Jack Paulin, Keeshent Thevanarayanan and Arun Raju) and client Finn Ross a 4th-year marine biology student, influenced and helped with the development of the design project throughout. This research was undertaken as a contribution to 'The Seaweed Solution' business plan.

AIM

THE AIM OF THIS PROJECT IS TO DESIGN AN UNANCHORED STRUCTURE TO GROW GIANT KELP IN THE OCEAN AND ACT AS "BLUE CARBON CAPSULE"

INDUSTRY BRIEF: The biodegradable structure is to be around 3-4m² that is free floating with bladders as buoys connected. The structure is to be negatively weighted after bladders burst to sink around 1000m below the oceans surface. It must be able to withstand the oceans harsh environment for around 8 months. A geotag design is to be included that can burst the biodegradable bladders when necessary.



OBJECTIVES

- Complete research into materials opportunities both theoretical and physical in the initial stages of design development -
 - Theoretical: Use the CES Granta EduPack and primary literature to compare possible material options and use the Eco Audit Tool to calculate carbon emissions of materials
 - Physical: Complete small-scale tests of proposed materials in seawater (ideally over mid semester break) with appropriated scaled environment as wave conditions
- Propose two final designs -
 - 1st Design: A refinement design of the pyramid structure the industry proposed that meets the industry aim
 - 2nd Design: A new direction design that I have an open mind to develop and evaluate that meets the industry aim
- Complete prototypes of proposed design structures -
 - Initial Process Designs: small scale mockup to test the structure durability and span etc.
 - Full Scale Prototype of Chosen Final Design: during final weeks to test against intended environment

STRUCTURE SPECIFICATIONS

- The biodegradable structure is to achieve a span of around 4 -5m² that is free floating with buoys connected
- Have an efficient size to span ratio that gives the seaweed the most access to direct sunlight
- Durable structure design that is built to withstand/prevent storm damage
- Grow the giant kelp plant efficiently

MATERIALS SPECIFICATIONS

- It must be able to withstand the oceans harsh environment for around 4 months with limited structural damage
- Must be biodegradable
- Ideally absorb carbon in production of material, to add to the structures amount of carbon stored
- Must be low cost, to not exceed the current carbon credit worth

BLADDERS/WEIGHTS SPECIFICATIONS

- A geotag design is to be included that can burst the biodegradable bladders when necessary
- Must have minimal environmental impact
- Must be able to be connected through GSP
- Must be able to withstand harsh marine environment



01



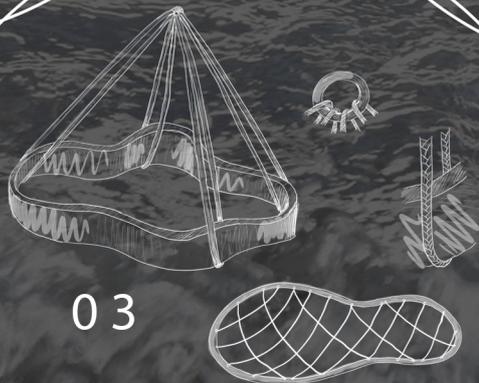
LASERCUT DESIGN

02



FLAT BAMBOO DESIGN

03



LAMINATED WOOD DESIGN

x3 CONCEPTS

STRUCTURE MATERIALS



BAMBOO

Needed per structure=
Around \$2/m
12m (x3 4m poles)
Total cost = \$24



HEMP ROPE

\$0.20/m for 12mm
Needed per structure
= 77.46m
Total cost = \$15.49



JUTE ROPE

\$0.525/m for 8mm
Needed per structure=
~1.68m
Total cost = \$0.88

BUOY AND WEIGHT MATERIAL



CORK BLOCK

200g = \$1.20 to \$3.75
(around 100mm/150mm/230mm)
Needed per structure=
584g (600g)
Total cost = \$3.60



HESSIAN SAND BAG

\$2.50 each from NZ source
Needed per structure=
x1 = \$2.50 + cost of sand (3kg)

Total cost with 20mins assembly line labour = \$53.14

FINAL DESIGN FEATURES



HESSIAN SAND BAG WEIGHT

DIAGONAL LASHING CONNECTIONS





THE SEAWEED SOLUTION

FINAL DESIGN

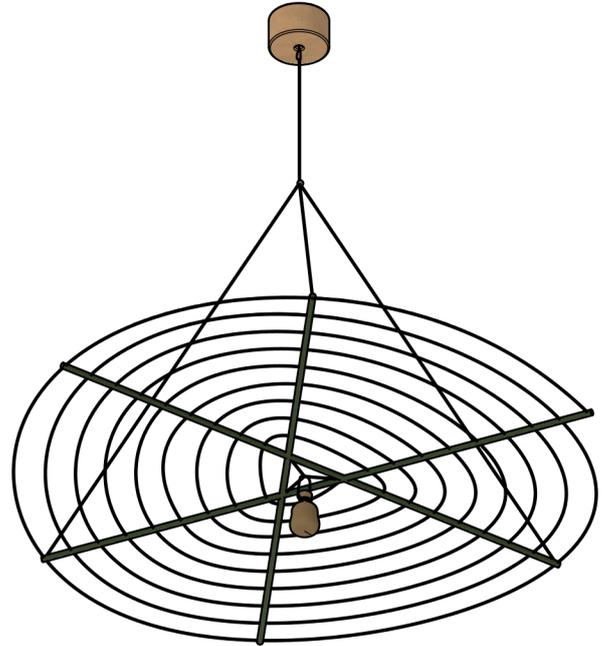
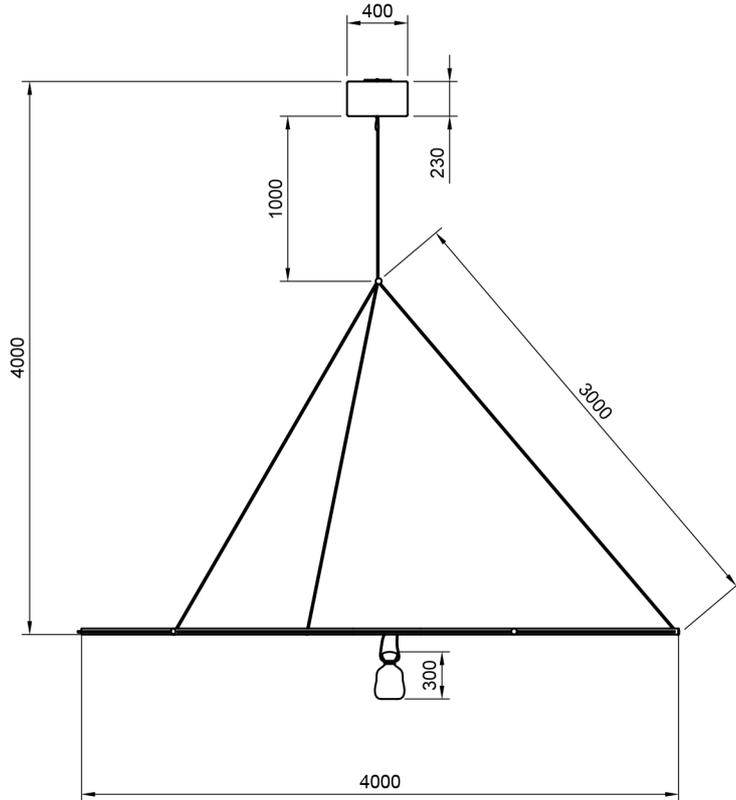




THE SEAWEED SOLUTION

"PIONEERING THE FIRST BLUE
CARBON CREDIT IN THE WORLD"





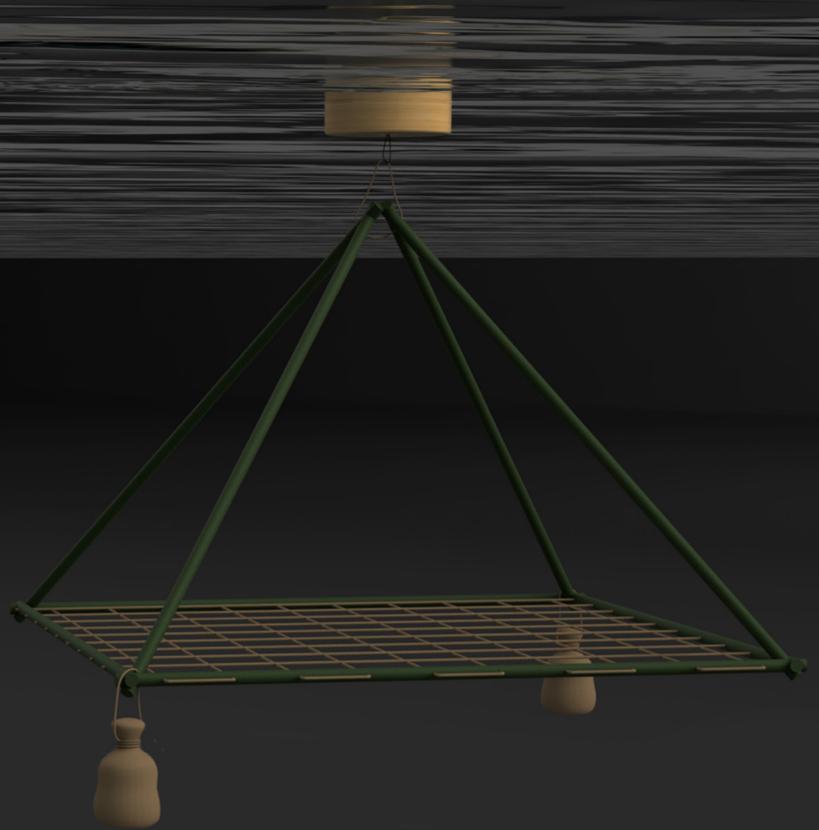
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REFINEMENT OF PYRAMID DESIGN

INITIAL DESIGN PRESENTED BY TEAM

REFINEMENTS MADE:

- Cork buoy was added instead of injection moulded bioplastic buoy
- Jute rope connection piece was added instead of GPS bursting mechanism
- Hessian sand bags were added instead of rocks or carbon bricks



COMPARISON OF DESIGNS

	PYRAMID	FINAL DESIGN
Poles of bamboo (4m)	x8	x3
bamboo/structure	32m	12m
Area/96m of bamboo	48m ²	82.48m ²
# of structures/96m	x3	x8
# of sand bags	x2	x1
Length of rope needed (200mm spacing)	160m	77.46m
Structure storage volume	16m ³	0.0423m ³



LARGE SCALE PROTOTYPE CONSTRUCTION



Step 01

Drill 12mm holes into the middle of each segment of bamboo, this is an approximate 200mm spacing.



Step 02

Gather three of the pre-drilled bamboo poles, they were 2m in length for this prototype but full size would be 4m.



Step 03

Align the three bamboo poles into the under/over cross over triangle shape with an equilateral centre triangle of 600mm. The distance from the triangle points to the end of the bamboo should be 1.7m for the 4m poles.



Step 04

Diagonal lashing rope connection is to be completed on the three triangles points.



Step 05

Base rope is to be tied and threaded through the drilled holes in a spiral network. Wax can be added to the rope ends to assist in slotting the rope through.



Step 06

Two 3m and one 4m structural ropes are to be attached from the larger end of each of the bamboo poles to a knot at the 3m point of the 4m rope. The end of the 4m rope is to be connected to the jute rope segment that will go through the centre of the cork buoy to an offcut bamboo stopper. A sand bag will then be attached to the centre point of the bamboo with structural rope.



ACKNOWLEDGEMENTS

I would like to thank my supervisor Tim Huber for his guidance and technological advice throughout the project and especially for his help in sustainable materials research.

Thank you to Finn Ross for his inspiring leadership and passion towards the project. It is a privilege to be involved with such an imperative topic of research.

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Finally a massive thank you to my family for their continuous support throughout my entire degree and life.