Aquamate Solar Still

The Aquamate solar still is light, compact, and easy to use. It utilises **solar radiation** to distil and collect pure drinking water from sea or impure water. The still will produce 500ml - 2L of water per day and has been used by military and civilian services throughout the world.

Advantages:

- Environmentally friendly
- Able to desalinate water
- No electricity needed
- Light and compact
- Easy to use
- **Autonomous after water is added**
- **Biomimetic design**
- 'One step' energy transfer (solar radiation -> heat)

Disadvantages:

- **Weather dependant**
- Slightly high cost at $240 per unit
- Unable to desalinate a constant flow of water.
- Unable to be used on land
- **Rate of desalination is low**
- Needs constant supervision
- May not be the most durable option
- **"Cradle to the grave"**

EVALUATION

The desalination process of the solar still mimics nature's water cycle. This biomimicry can develop efficient and appropriate solutions to the need. The autonomy and ease of use of this product will be considered when designing the final prototype.

WaterFx Solar Desalinator

San Francisco based company, WaterFx has developed a solar desalination unit using **parabolic mirrors** to concentrate the sun's energy, heating a tube that then **distils fresh water out of salty drainage**. This project was created for the purpose of turning salty, contaminated agricultural drainage into fresh water that can be re-used to irrigate crops. **Powered not by fossil fuels, but by the sun**.

Advantages:

- **Carbon neutral**
- **Efficient desalination process**
- Able to desalinate a **substantial amount** of water
- Uses **renewable** and **sustainable** solar power.
- **'One step'** energy transfer (solar radiation -> heat)
- Constant flow of water, increasing **efficiency** and **autonomy**.
- Durable + low maintenance and operational costs.
- **"Cradle to Cradle design"**

Disadvantages:

- Heavily **weather dependant**
- **High upfront cost**
- Not suited for individual use (family use)
- Not portable, fixed design
- Yield of distilled water varies on climate
- Parabolic mirrors need to be maintained to retain high efficiency
- Weather, temperature, mirror cleanliness and cloud coverage will impact the yield.

EVALUATION

This design uses a parabolic trough mirror to concentrate the sun's energy to heat the tube. This is a very **sustainable** and **environmentally friendly process** as there are **no expendable items** in the process and is **solely using solar power**. This is a very **valuable design**, in which **all aspects** of it will be **taken into consideration** for the MDP.

MATERIAL RESEARCH

The materials of the MDP are split into 3 sections

Main Frame | Pipe | Reflector

Radiata Pine - $

Advantages: Pine is an **inexpensive**, **lightweight** wood that can be yellowish or whitish with brown knots. It is a **renewable source**, **harvested** from **plantations** that are **regulated by government organisations** to ensure **low impact on the environment**. Treated pine is **highly durable**, shock resistant, stiff and **weather resistant**. Also, Pine is very **easy to work with** and can be manipulated relatively easily with work tools.

Disadvantages: Pine is a softwood, so it's **prone to scratches and dents**. **Prone to movement** compared to all other timber, for example, **shrinking** and **swelling** when seasons change, due to higher and lower levels of moisture, which can also **interfere with paintwork**. **Increase maintenance**, **signs of wear** and potential for excessive knots.

EVALUATION

The **durability** and **low environmental impact** are great qualities for the main frame of the desalinator as this will ensure **longevity** and **sustainability** of the product. Treated pine, commonly used for outdoor furniture, will be a superior option as its **weather resistant** characteristics will be highly valuable in this project. This **will be used** for the side supports.

Reclaimed Timber - $

Advantages: The two main advantages of recycled timber is the **affordability** and **low environmental impact**. Also, as old timbers have expanded and contracted over the years and are fully dried out. This makes them more **durable** and **less prone to warping and splitting**. This also adds an **aesthetic character** to the timber, making it **unique**.

Disadvantages: Since the timber is reclaimed, there is a high chance of **size irregularities**. This will heavily impact the amount of **time** and **commitment** needed to form the timber into the intended shape. Also the **upfront cost** may be unknown depending on the supplier.

EVALUATION

The **durability**, **affordability** and **low environmental impact** of reclaimed timber are very **valuable** characteristics that are excellent for this project. An additional coat of oil will ensure that the timber is **weather resistant**, a **vital feature** needed for this project. However, due to the **uncertainty of shapes and sizes**, this timber will not be used.

Spotted Gum - $$$

Advantages: Spotted gum is able to **tolerate harsh weather conditions** and is commonly used for outdoor decking. Being one of the **toughest hardwoods** It is **highly durable** and **decay resistant.** It is **locally sourced** on the east coast of NSW, meaning the **overall carbon footprint** will be **reduced**. It is to a degree **fire resistant** and **UV resistant**.

Disadvantages: Spotted gum often takes 30 to 50 years from planting to harvest. This impacts the sustainability of the material as well as the cost of the timber, making it the more costly option amongst other timbers . Due to its unique composition it is very dense and heavy as well as being difficult to treat effectively as the timber does not absorb the preservative treatments.

EVALUATION

The **fire resistant quality** of spotted gum is highly favourable as this product will likely encounter the element of heat. This fire resistant quality will ensure **safety** and **longevity** of the product. It's **high cost** is an **impediment** for **future plans** of **mass distribution.**

Plywood - $

Advantages: Plywood comes in a **variety** of **sizes** and **thickness**, thus being **very versatile**. This is a very favourable factor as plywood below the thickness of 5mm can be **laser cut**, a **CAM process** whereby a laser **precisely** cuts the sheet. Also, due to its '**lamination**' process, plywood is **structurally sound** and **will not warp** as the **cross lamination** will prevent any warping in certain directions. Plywood is also **very cheap** and **easily accessible**.

Disadvantages: Plywood, although quite enduring, is **not the most durable** wood, compared to other solid woods. It does tend to **chip** quite easily and when compared to other woods, does **not handle wet weather or moisture very well**. Also, if plywood is sanded to the extent in which the top layer is removed, the surface of the wood will display an unappealing surface.

EVALUATION

The **versatility** of plywood regarding its sizing, allows for **CAM**. This is a very advantageous trait as it then **enables for mass manufacturing** and **precision** when manufacturing the project. This also **facilitates independent production** in the islands, as CAD files can be **easily transferred.** This will be the main material used to create the prototype.

Aluminium - $$

Advantages: Aluminium is a **lightweight** metal able to **tolerate harsh weather**. Its aluminium oxide layer gives the metal the **inert** characteristics, making it **less likely to corrode**. Aluminium is also very **durable** and has the **highest strength to weight ratio**. Aluminium is also **100% recyclable** thus more **sustainable** and **eco friendly**. Aluminium is also able be manipulated by using the **CNC** router, creating machine **precision** and **consistency**.

Disadvantages: Aluminium is the more **expensive** option as it is a metal. Although aluminium is 100% recyclable the extraction and production of most aluminium is not 100% sustainable and carbon neutral. Also, aluminium, if damaged can be very hard and costly to repair.

EVALUATION

The **strong** and **lightweight** characteristics of aluminium is **highly valuable** to this project, as it will enable **longevity** and allow **ease of transport** and **use**. It's **chemical inertness** will also be beneficial as water will be a key element in this project. Although its **high cost** may be an **impeding factor** for this option.

Main Frame	**Pipe**	Reflector

Copper - $$$

Copper, the 29th element in the periodic table is one of the most widely used metals in the world. **Advantages**: This reddish-brown metal is **highly versatile** and advantageous for a wide variety of applications. It is one of the **best thermal** and **electrical conductors**, only 2nd to silver. Also, due to its chemical formula, copper is very **resistant to corrosion** and is generally a very **inert material**. It is also able to be **recycled readily**.

Disadvantages: Copper is on the more **expensive** side of the pure metals. Also, copper is quite **dense** meaning that the **weight** may pose some issues. The extraction of copper is predominantly **mining**, which has almost **permanent damages** to the **environment**.

EVALUATION

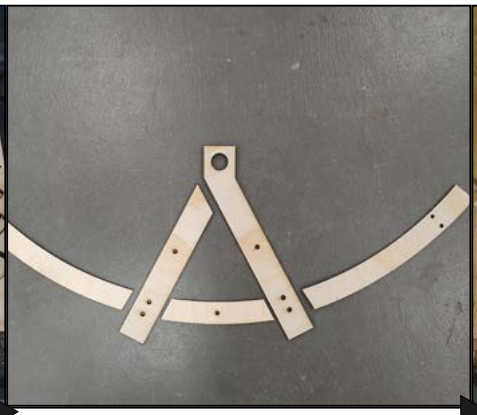
Copper's high **thermal conductivity** makes it a favourable material for the boiler pipe as the **efficiency** of the **desalination process** will be greatly enhanced. Its **resistance to corrosion** with water is a **highly** advantageous characteristic for this design as the pipe will always be in contact with water.

PROJECT PROTOTYPING / TESTING

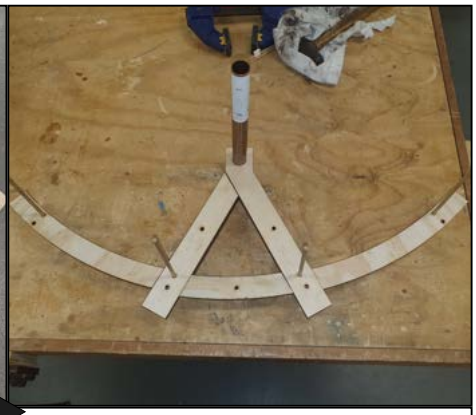
Laser Cutting and Assembly v1

The final cutting list will now be transferred to the laser cutter to cut and be assembled afterwards. The method of laser cutting still has not changed and laminating technique is also the same. The purpose of the assembly is to check the interaction between other components of the prototype as well as inspecting the interaction between parts. This ensures that if any parts are not the right size, a quick alteration can be made to the cutting list.

The parts were laser cut in stages and parts placed with the same types. This ensures the right number of pieces is printed.



The first part of the assembly checks the interactions between parts, making sure that they are all aligning as seen in the 3D model.



The second assembly checks the interaction between the part and already acquired components such as the dowel and the copper pipe.

EVALUATION

The assembly process is the first time the design idea has manifested into the real life 3D object. This is a great opportunity to gain insight into any alterations that need to be made to the design. The interaction between the parts in the assembly did not need any further alterations or modifications.

Assembly v2

After more parts were cut out the structure of the frame started coming together. However, the realisation was made that the original intended laminating thickness was going to be to thick. The original design noted 14 layers of plywood or 42mm in thickness. The sheer weight of this many lamination was too much for the 'lightweight' design. It was decided that due to the weight of the lamination the final prototype would have 9 layers in total or a thickness of 27mm. This decision was made on the basis that 9 layers should still have enough rigidity and structure to keep the prototype functional and keeping it at a low weight.

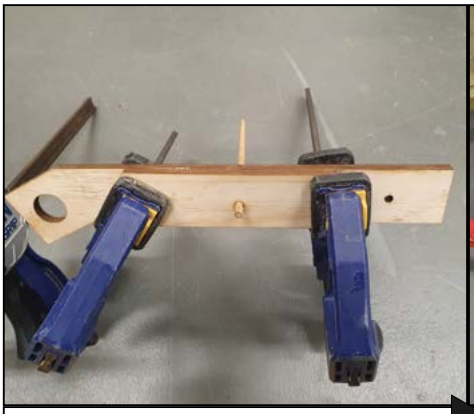
EVALUATION

The second assembly provided insight into the thickness of the prototype. Out of this a realisation had occurred, the components were to thick and needed to be reduced down to maintain the lightweight feature. Therefore, both the frames will be reduced to 9 layers from 14 layers.

PROJECT PROTOTYPING / TESTING

Assembly v3

Testing the assembly allows for design flaws to arise. It is critical to do this before the final assembly of the prototype, to ensure alterations can be made to oppose the flaws.

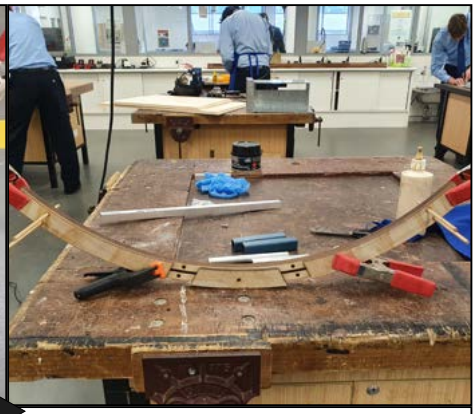


Stage 1

Parts we glued using a combination of quick grip and spring clamps. There were 7 unique parts that had to be joined together.

Stage 2

The second stage of the assembly was the large back curve, this posed some issues such as warping, due to the thinness of the part.



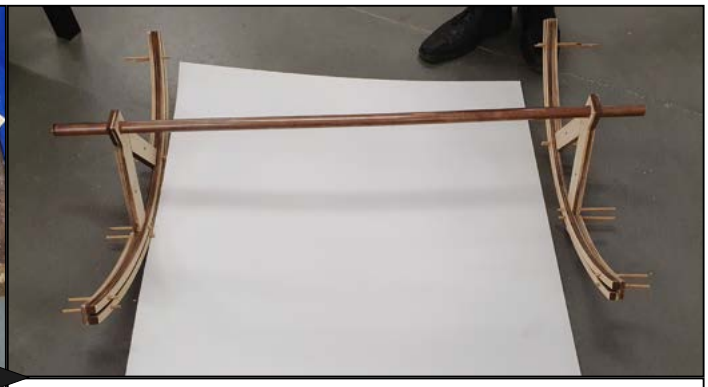
Stage 3

In stage 3 the back curve was joined to the front components. This process was mainly using the spring clamps , due to their versatility and mobility.

EVALUATION

The only issue that arose from this stage of prototyping is the warping that occurred with the large curved back piece of the prototype. This was found to be due to the excess use of water when cleaning PVA glue off the part. The component will be set aside and a large weight will be placed on top to counteract the warping.

Both sections of the frame was now glued on after waiting for the rear curved part to ‘de-warp’. At this point the process will be repeated for the 2nd frame.



This is the last assembly before fixing all the components together. This is also the first time the frames have interacted with both the corflute and copper pipe. It was found in this assembly test that the frame may not have enough integrity to hold the corflute steadily in place.

EVALUATION

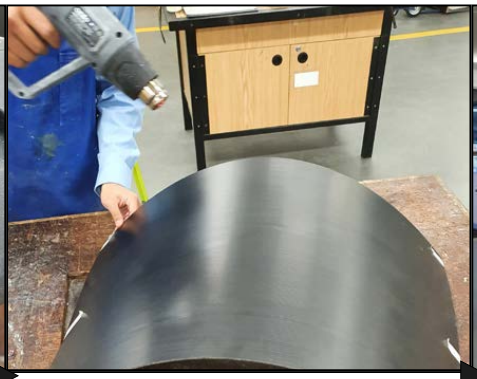
The last assembly identified a functional issue within the design of the prototype. The corflute would need a considerable amount of force to keep it in a curved position. Hence further experimentation will need to occur to find a solution to this issue.

PROJECT PROTOTYPING / TESTING

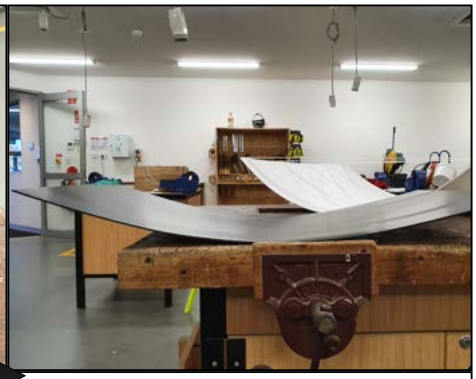
Bending Corflute Test

Due to the amount of force needed to keep the corflute in place, adaptive experimentation needed to be carried out to determine a solution. This experiment will test if corflute will stay in the same position if heated. A spare piece of corflute is used as well as masking tape and a heat gun.

A heat gun was acquired as well as a spare corflute sheet.



The corflute was bent and held in place with three strands of masking tape. Then I proceeded to heat around all the corflute, making sure to have consistency.



After 3 minutes of heating the corflute, the masking tape was removed. The corflute had a slight curvature to the once straight sheet.

EVALUATION

This investigation revealed that heating the corflute at a certain position will encourage it to stay in a similar position. This process may be used in the final prototype. More likely, this process may be used in conjunction with another element to keep the corflute in the parabolic position.

Spray Paint Test

The copper pipe will be painted with black spray paint to absorb more solar energy. 2 different types of spray paint will be compared. This test will determine which of the two is the most appropriate option for the copper pipe.

Firstly the copper pipe was sanded with 800 grit sandpaper, then cleaned with a cloth. The pipe was then sprayed, ensuring to record which paint it was.

The left coating if from the left spray can. The left coating had minimal to no imperfections, whilst the right had air bubbles forming on the surface of the coat.

EVALUATION

Through visuals and touch the left coating is clearly the superior coat of paint. It feels much smoother in hand and visually is seen as much more even and rich in colour. Therefore, the final prototype will be using the left spray paint can to coat the copper pipe.