floreo

Project Summary

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Product Overview

Floreo

Floreo is a multi-use sheltered growing dome for urban community gardens, which can transform in response to the changeable Scottish weather and needs of the community.

Product Aim

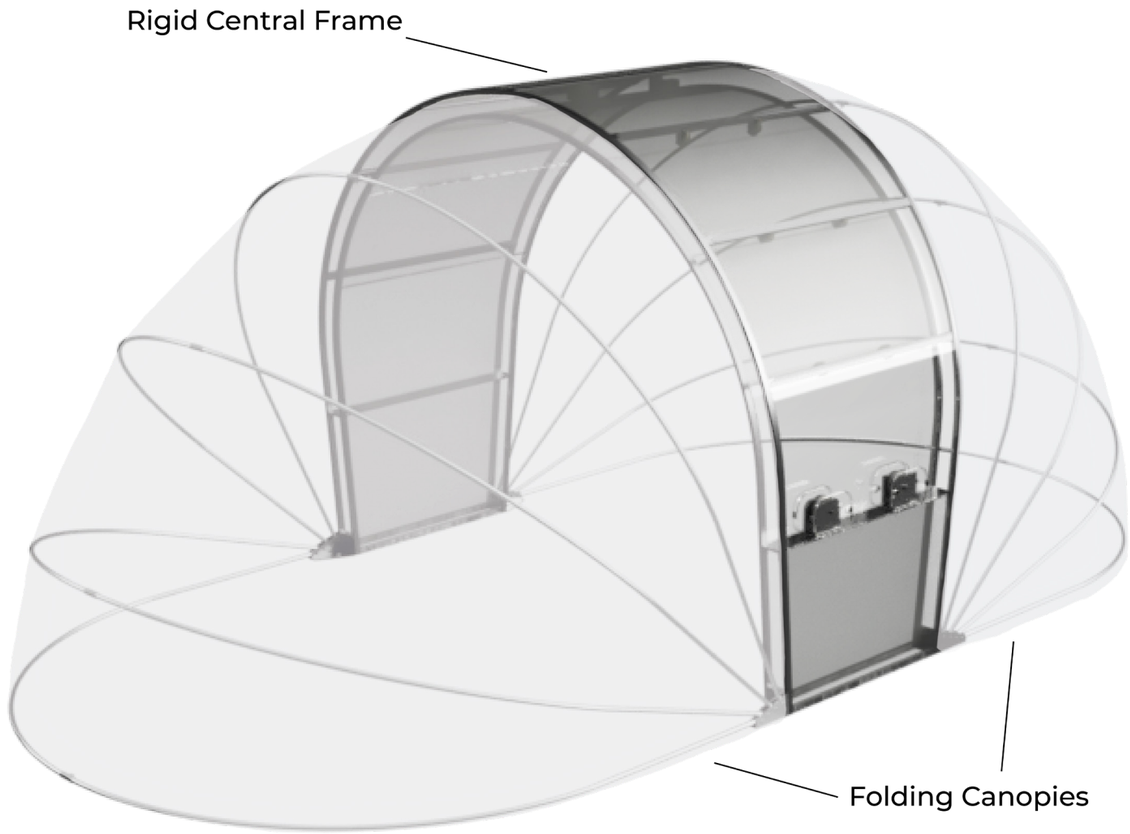
The aim of the product is to encourage communities to maintain their connections to nature and food growing throughout the year, and supporting the development of local food networks.

Environment

Community spaces in urban Glasgow become uninviting during the winter months, when growing conditions are far from ideal.

The User

Floreo is an inclusive product to be enjoyed by all within the community, becoming a hub for growing, education and socialisation.



Research Summary

The Problem

As the global population is increasing, the fragility of world-wide food security, accessibility and the environmental impact of food production is becoming a more alarming issue. To address this, we must work towards building sustainable and resilient food systems to help reduce food waste and transportation emissions, encouraging a global change in mindset towards our relationship with food and how it is produced.

9.8billion

is the predicted global population by 2050.

70%

is the increase in agricultural output needed to meet demand.

68%

is the proportion of people projected to be living in urban areas by 2050.

Rapid population growth

Urbanisation

Growing wealth and change in consumption patterns

One way of tackling this is to introduce food production back into our cities through urban agriculture. **Urban Agriculture (UA)** can present itself in many forms, and whilst most commonly recognised as larger scale commercial endeavours, it can also refer to **small-scale individual and community projects** that focus on providing cities with social rather than economic gain. Community growing also **offers a multitude of additional benefits such as encouraging social inclusion, improving mental health, increasing green space and city beautification.**

Growing in Glasgow

Growing fruit and vegetables in Scotland can present its own set of challenges due to its unique climate, differing from that of the rest of the UK, and even having variations across different Scottish regions, where temperature, wind rainfall and daylight hours can fluctuate. Therefore, growing strategies from gardeners in the south of England cannot always be applied here, making it essential to consult with stakeholders familiar with the local growing conditions, food systems and public health in Glasgow to obtain region specific knowledge and experience.

A number of Glasgow based local food stakeholders were contacted to identify pain-points, resulting in the following insights:

Research Insights & Conclusions

- Challenges with Scottish climate - lack of shelter and comfort
- Urban sites - lack of green space and polluted land
- Growing isn't viewed as a required life skill
- Community growing sites can be space and resource limited
- Community growing offers wider benefits - mental & physical health, education and social inclusion

Good food for all
GLASGOW FOOD POLICY PARTNERSHIP
THE BOWLING GREEN
Children's Wood
SHETTLESTON COMMUNITY GROWING PROJECT
LOCAVORE
GROWCHAPEL COMMUNITY GARDEN
GLASGOW COMMUNITY FOOD NETWORK
Glasgow CITY COUNCIL
Refuweegee
(ref-u-wee-gee)
noun - A person who upon arrival in Glasgow is embraced by the people of the city, a person considered to be local.
see also Glaswegian -
We're all fae somewhere

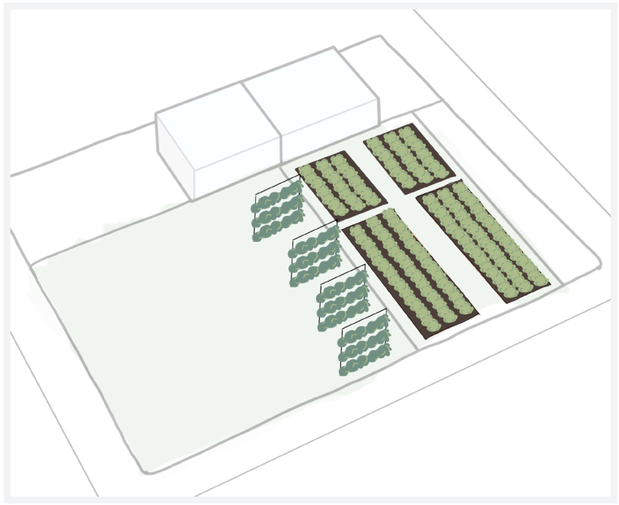
Concept Generation

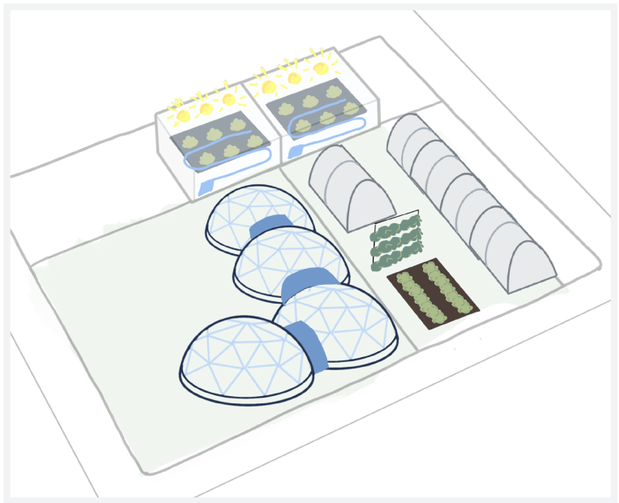
Identifying Project Focus

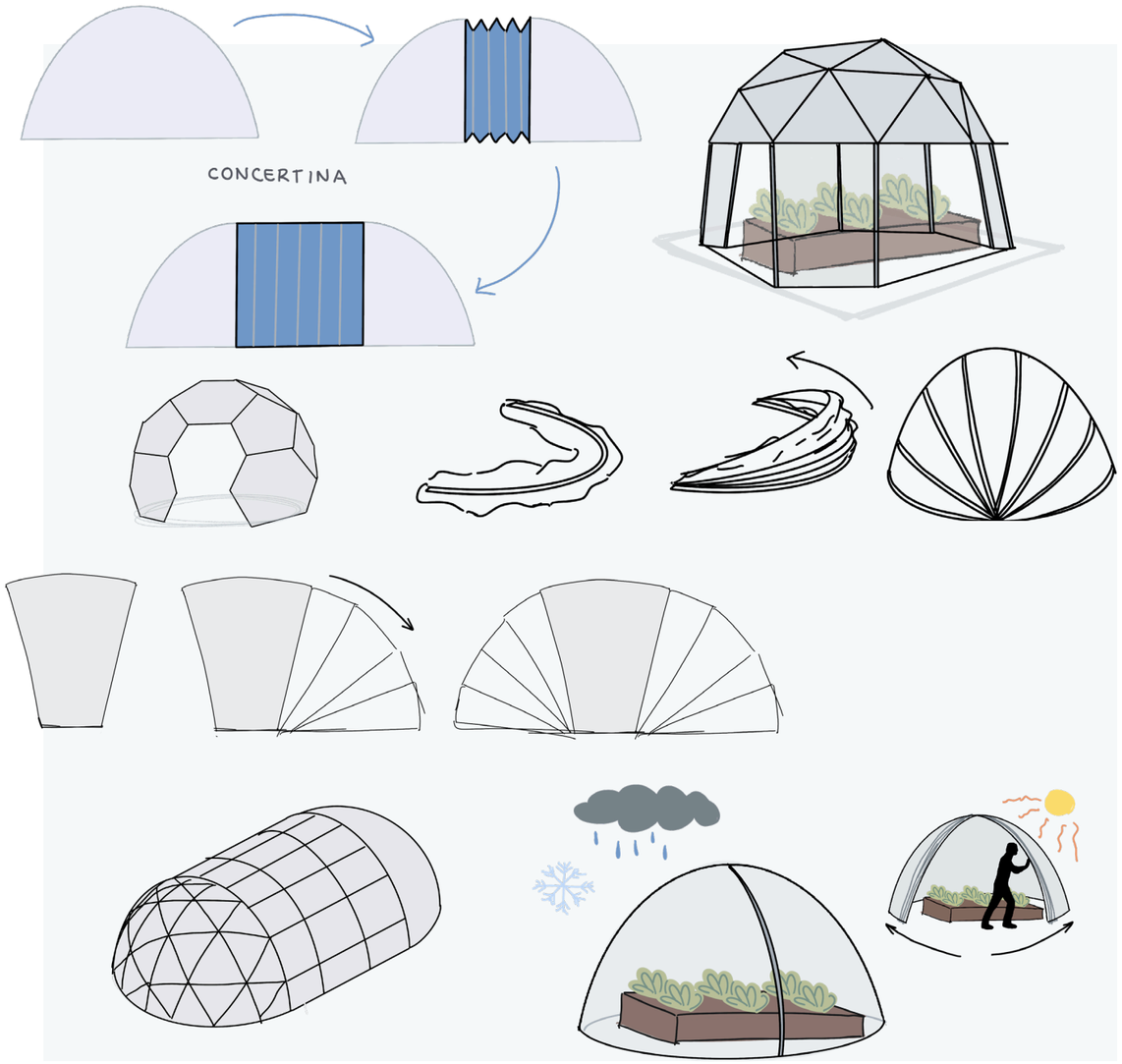
Food security and accessiblity is a multi-faceted problem to which there is no single solution, therefore extensive research was required to narrow the problem within the scope of this design project.

This was achieved by first **considering how community gardens could change throughout the year**, to make them better equipped for the changeable climate, and considering how each component within the wider system could work together to achieve this. A number of potential project routes were considered, including **various methods of food growing, food storage and preservation, green energy generation and access to shelter.**

A weighted concept evaluation matrix was generated to identify the most promising route to proceed with, when considering factors such as community benefit, technical scope and design unique selling points. This evaluation concluded that further development of an **innovative sheltered growing** product would best address the challenges of building and maintaining relationships between people, nature and food, whilst promoting environmental awareness.







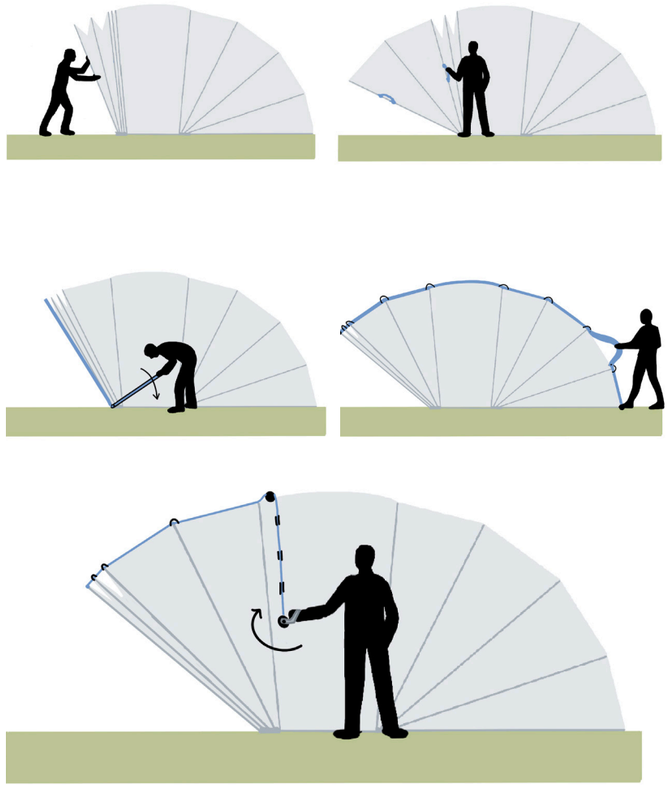
The Brief

Improving the facilitation of year-round growing activities in community spaces.

Focused Ideation

Focused concept generation involved exploring various ways a protective growing structure could **adapt in response to changing weather and community needs**. During development, two different shelter categories were investigated: temporary (deployable when required) and permanent but adaptable. The requirements of a protective growing structure, how often and for what purpose it would be used throughout the year, were extensively considered, and identified that a **permanent structure with functional flexibility would be most suitable.**

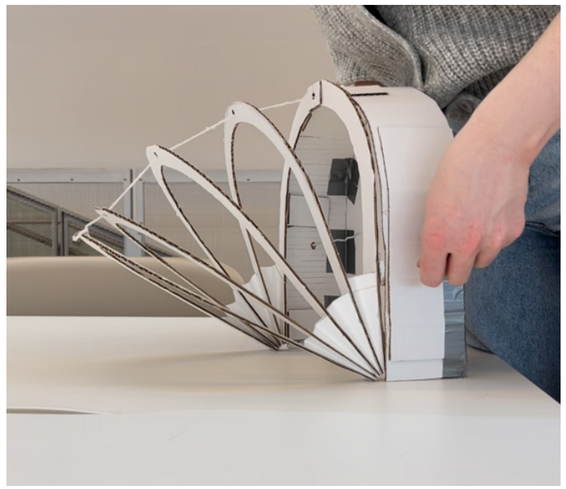
Development

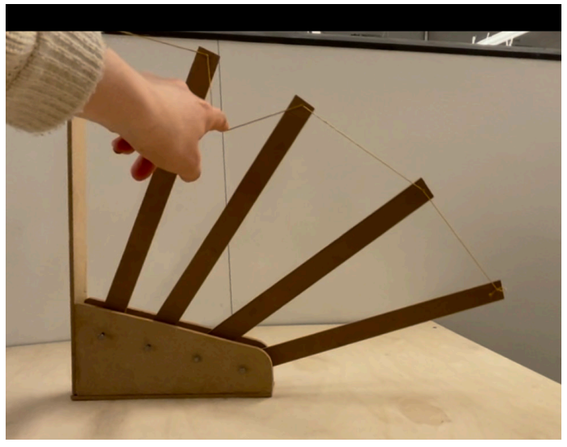


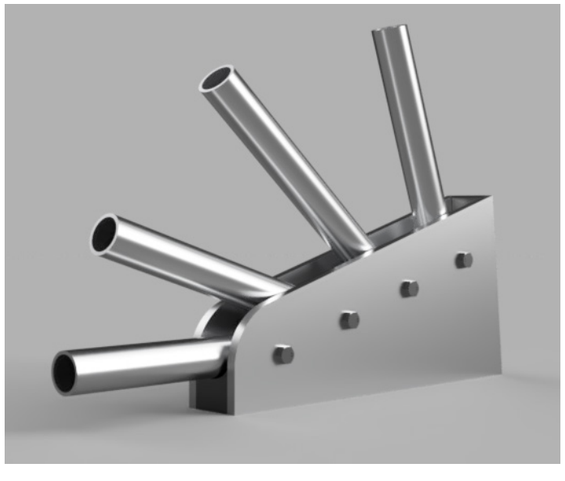
Opening Methods

The method by which the folding canopies could be opened by the user was one of the main design challenges within this project. Several techniques were considered, including opening by hand, a pull cord or using the mechanical advantage of a lever or pulley and handcrank.

User requirements guided the design process where **ease of use, user accessiblity and health & safety were identified to be of most importance.** Following evaluation by a weighted concept matrix, a pulley and handcrank system was identified as the concept that would most successfully deliver the design criteria.







Understanding the Mechanism

Once the chosen opening mechanism was identified, a rapid prototype of a 1:10 scale working pulley and crank system was constructed. This **allowed me to visualise the product function** and identify the key design aspects within this system to be addressed, such as the directional transfer of the pulley cable and the hoop hinge point.

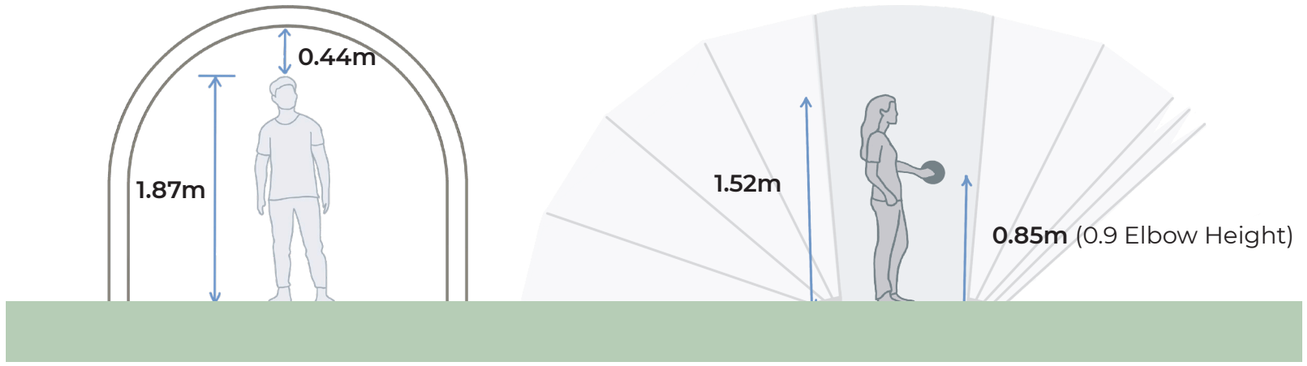
Design Refinement

The hoop hinge point was prototyped at a 1:1 scale to identify the hoop fixture positioning and **ensure no interference** between the pivoting hoops occurred.

Final Hoop Hinge Mechanism

The final mechanism design included the addition of a hoop rest, supporting the base hoop when the canopy is in the closed position and relieving tension from the ETFE thin film.

Development

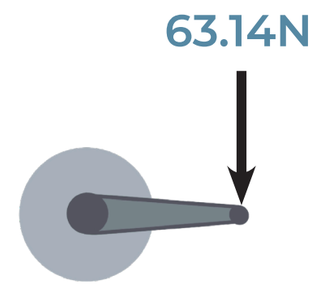


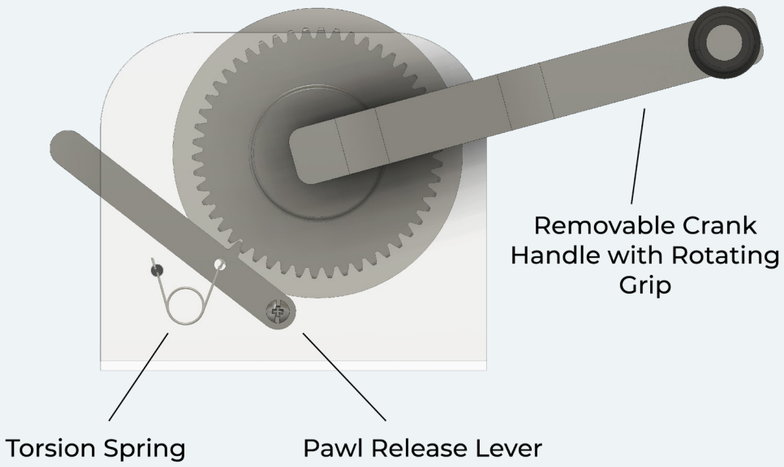
Anthropometrics

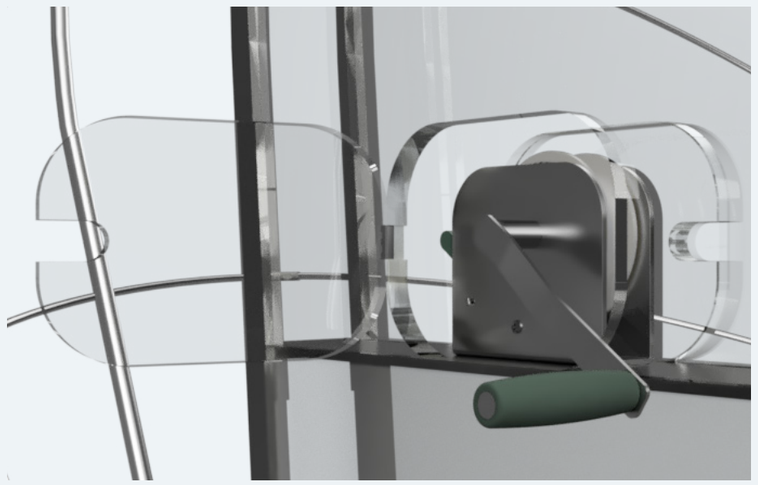
Anthropometric data collected from PeopleSize 2008 software was used to determine the dome dimensions. The **structural height was designed for the 95th percentile male** (largest user), where the structure allows 0.44m headroom at dome centre and an upright walkable footprint of 7.87m^2. The optimum height for the **winch central axle is 0.9 times elbow height of the 5th percentile female** (smallest user), positioned at 0.85m from ground level.

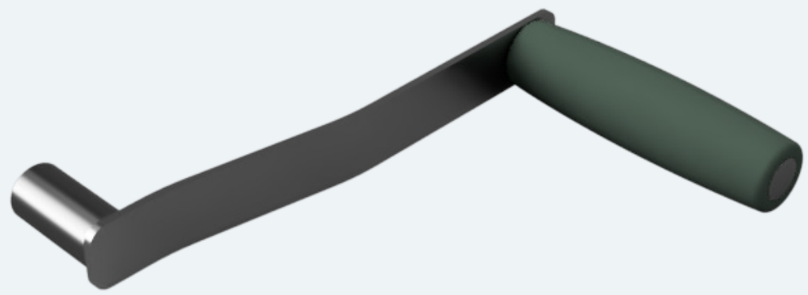
Force to Operate the Winch

Ergonomic standards identified the **recommended maximum cranking force to be 130N**, and therefore the pulley system should not exceed this to ensure product accessibility. Force analysis was carried out on three diameters of aluminium tubing to determine the most suitable for canopy hoop application. It was concluded that the **19.05mm (3/4") diameter tubing required an applied force of 63.14N. This is less than 50% of the maximum recommendation** allowing for variances in the external environment, strength abilities of the individual user and factors such as the wearing of gloves to not impede upon user accessibility.







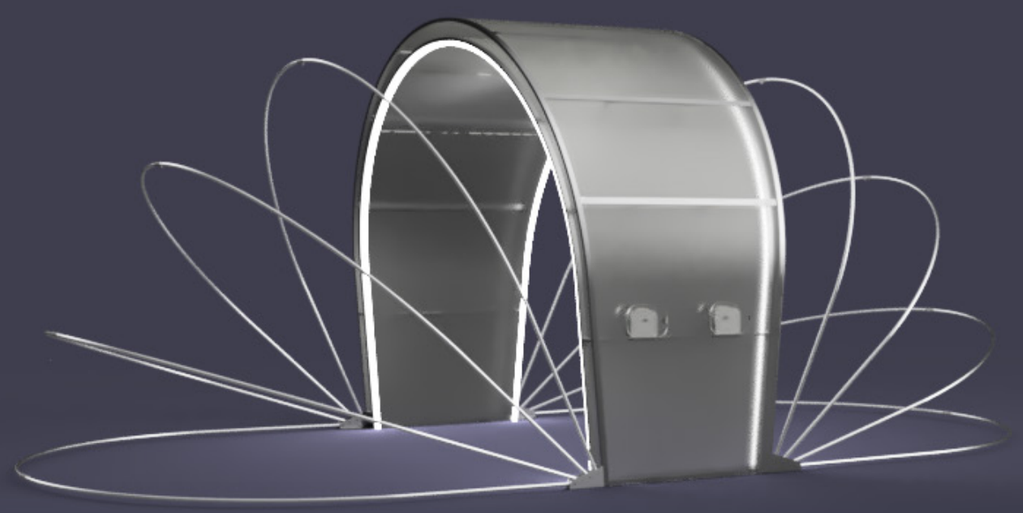


A **winch with automatic locking mechanism** composed of a ratchet and pawl with torsion spring, allows the user to open the canopies to any position without the need to manually secure the system. To close the canopies, the pawl release lever can be activated to release the brake from the gear teeth and permit the winch to rotate in the opposite direction.

A crucial design factor was to ensure the winch mechanism was not visible to children preventing the likelihood of injuries occurring. **Hatches have therefore been included to conceal finger traps in the exposed mechanism** when the winch is not in use, mitigating the chance of product misuse.

Following the addition of the hatches, the **crank handles were modified to be removable** so as not to interfere with the hatch doors. The rotating handle grip was also designed to have a maximum diameter of 30mm, ensuring it would be possible for the smallest user (5th percentile female) to achieve a secure grip when operating the winch and subsequent canopy.

Development



The electronic specification was devised to prioritise the visual requirements of the user when working within the dome.

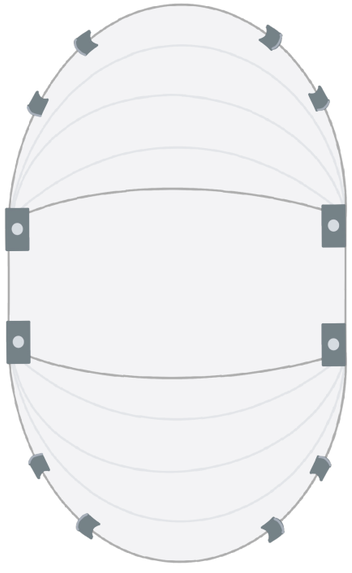
The system comprises of two flexible LED light strips following the curve of the central frame, powered by a 60W solar panel which allows the product to be used on off-grid growing sites.

A 33Ah deep discharge battery accounts for 48 hours between charges and 30% depth of discharge to maintain battery health. In addition, the system has the capability to charge a mobile phone in case of emergency.

Ground Anchors

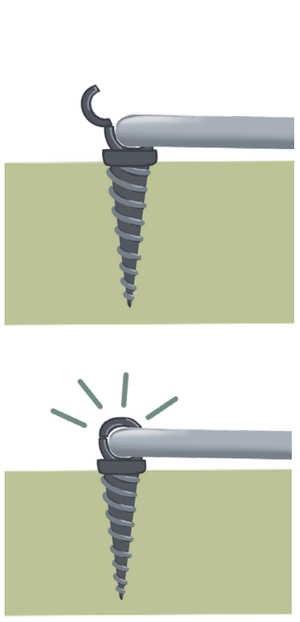
The growing dome is **secured to the ground by 12 anchor points,** four securing the central steel frame and four securing each canopy.

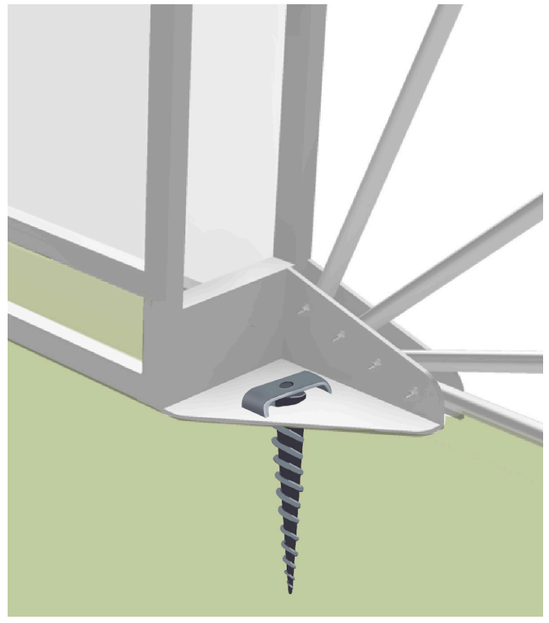
The steel anchors can be screwed into the ground, requiring minimal effort and ground preparation, **allowing the structure to be disassembled and relocated if required**. If necessary, additional measures to secure the structure could be employed depending on site exposure and ground conditions.



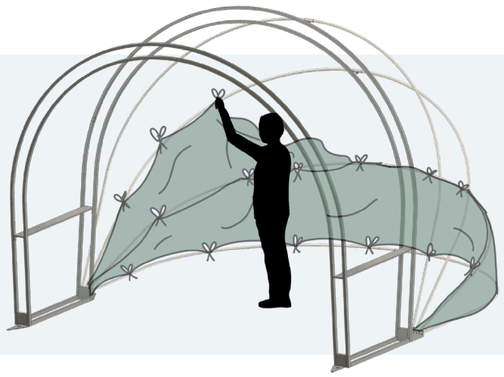
The **canopy hoops are secured by snap closures,** which would be required when Floreo is subject to windy conditions.

The hoop anchors can be **accessed from both inside and outside the dome** via slots in the ETFE thin film and must be released before opening the canopies.





Microclimate Control



Solar Shield

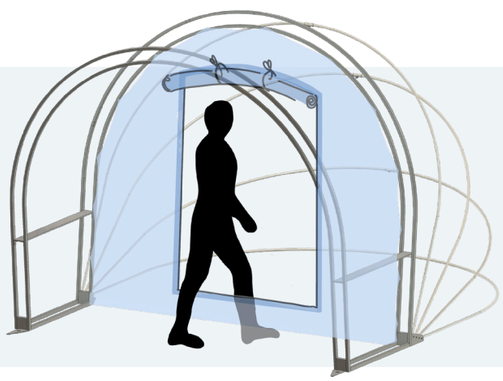
The solar shield is a **knitted polypropylene monofilament** fabric covering that can be attached to the inside of the canopies. This provides the plants with shading and reduces temperature within the dome during warmer weather.

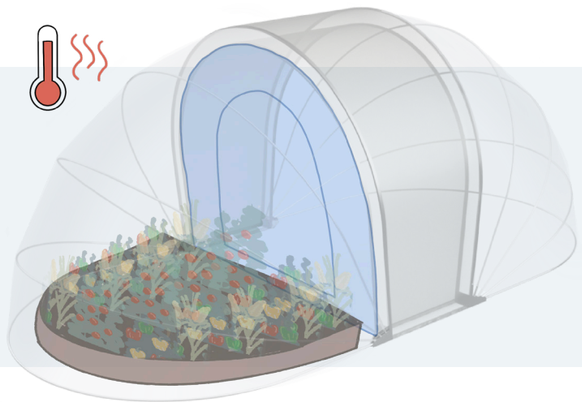
UV can cause sun scorch, dehydration and affect photosynthesis.

Ventilation is essential year-round to prevent the spread of mould and disease.

Ventilation

Ventilation has been incorporated into the structure by manual louvre vents, slots in the ETFE thin film for ground anchors and the ability to open the canopies. **1m² of ventilation** is required **per 20% of floor area** to allow for a **complete change of air every 2 minutes.** Floreo requires 5m² of ventilation for its 16m² footprint.



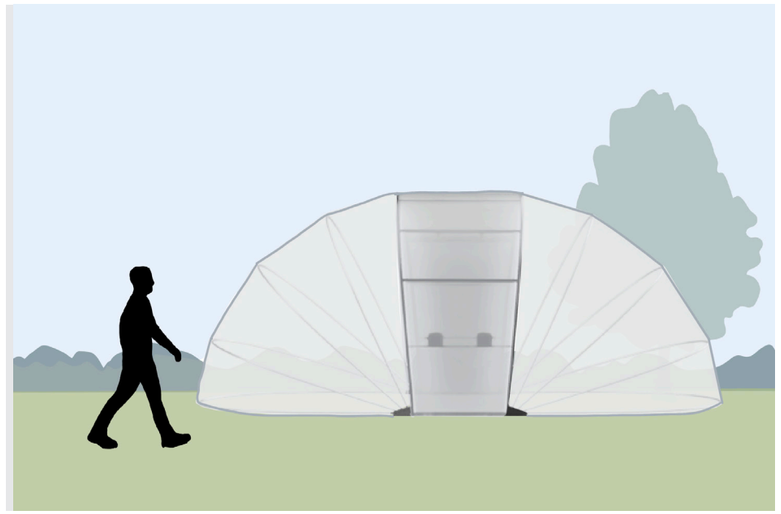


Hot Room

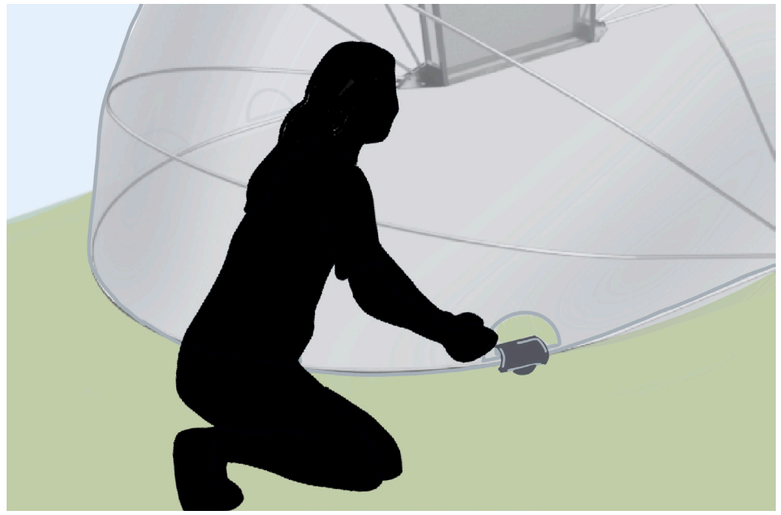
The “hot room” ETFE compartment creates an additional enclosed and consistent microclimate of smaller area within the dome. The purpose of this compartment is for **plants that thrive at higher temperatures** and to **extend the growing season** for early and late crops.

Can maintain a stable microclimate whilst benefitting from Floreo’s indoor-outdoor adaptability.

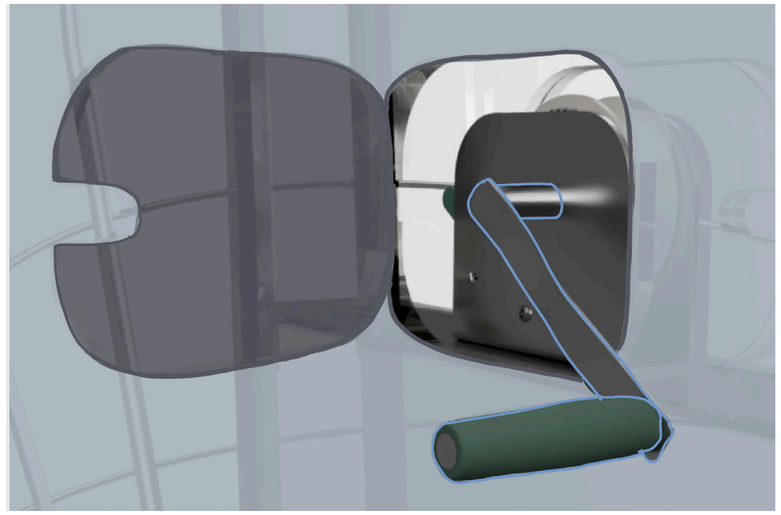
User Interaction



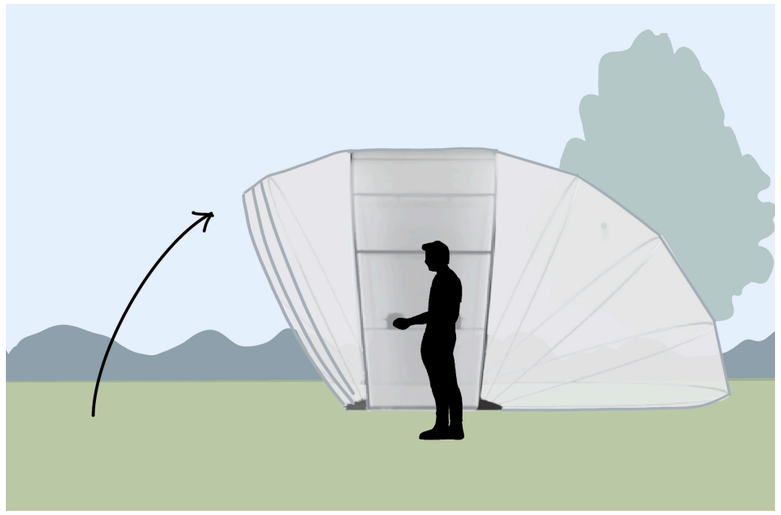
A community growing leader arrives at the site



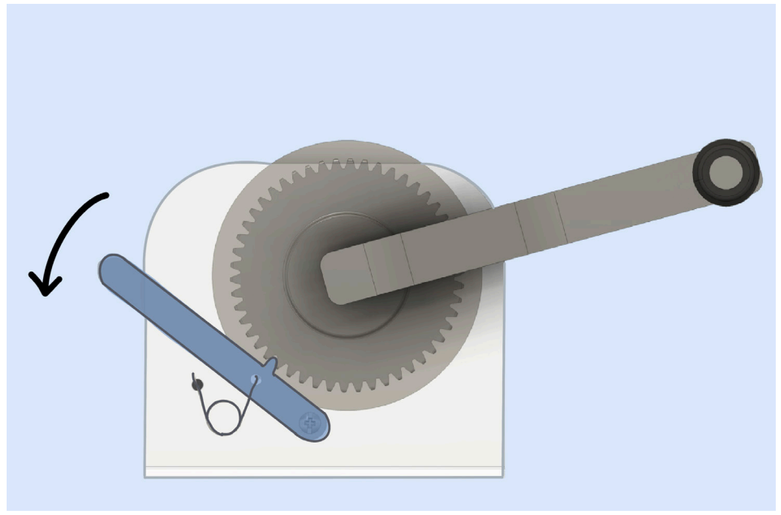
The canopy anchors are released



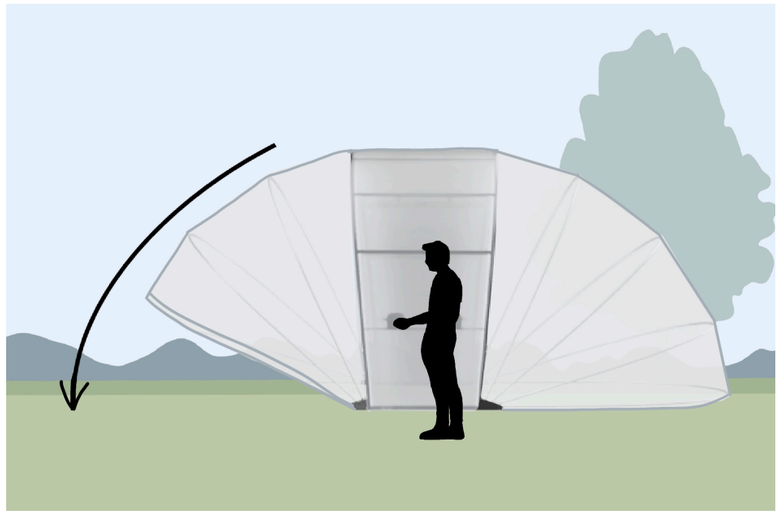
The winch hatch is opened and crank handle attached ready for operation



The canopy can then be opened to any desired position and automatically locked by the winch



The pawl lever is activated to release the brake, allowing the winch direction to reverse



The canopy can then be closed and locked back into place by the anchors

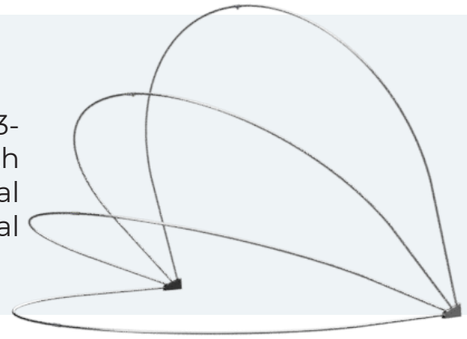
Materials & Manufacture

Steel

Medium carbon steel was the material of choice for the main structural frame, selected for strength and stability and manufactured by extrusion. The steel is hot dipped galvanised and annealed instantaneously to improve corrosion resistance for outdoor use.

Aluminium

The canopy hoops are made from hollow aluminium 6063-T6 tubing, selected for its low density but excellent strength to weight ratio. The tubes are extruded, shaped by manual 3-roll-bending and anodised to prevent environmental degredation.

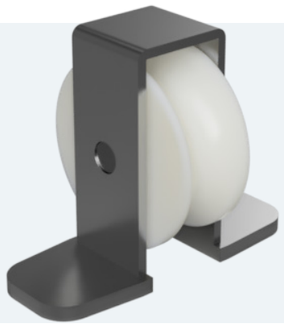


ETFE

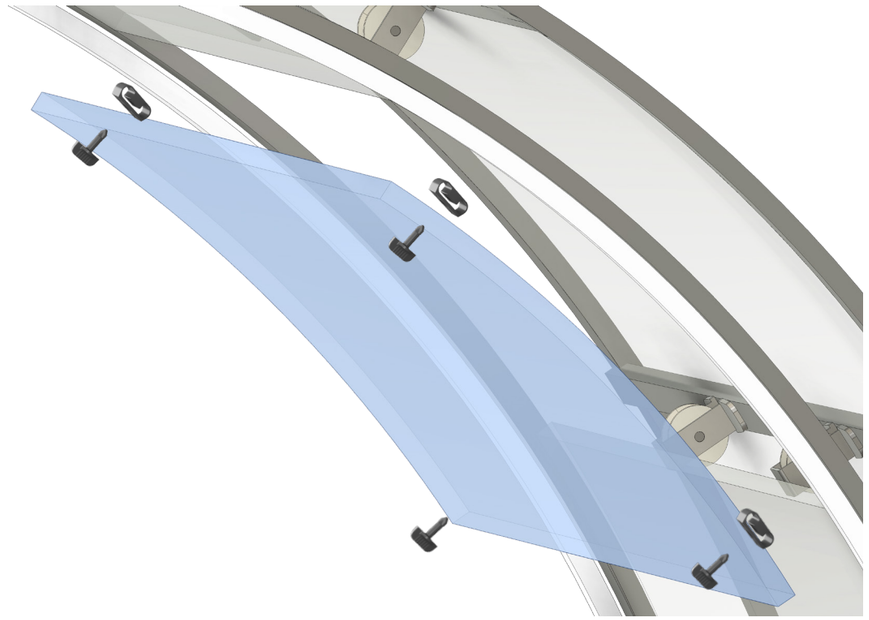
Ethylene terafluoroethylene was selected as the material for the folding canopies and rigid panels for its excellent horticultural properties. Both forms of ETFE are manufactured by polymer melt extrusion.

Nylon

Nylon 6/6 has been used for the cables and pulleys due to its high strength and resistance to fatigue and wear. Nylon to Nylon static friction coefficient is 0.15-0.25 which will aid in canopy closing where fricion is undesirable as the winch motion is reversed.



Maintenance

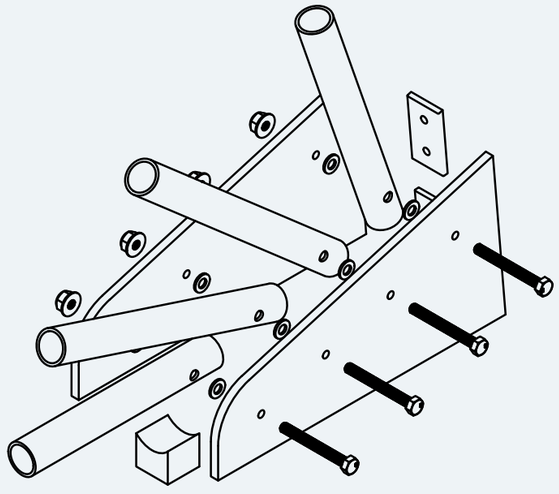


The **responsibility for day to day maintenance** will fall on members of the community group, where they will be expected to perform any cleaning tasks and visual inspections. ETFE however, has a low friction coefficient requiring minimal cleaning, and minor tears and punctures can be easily repaired.

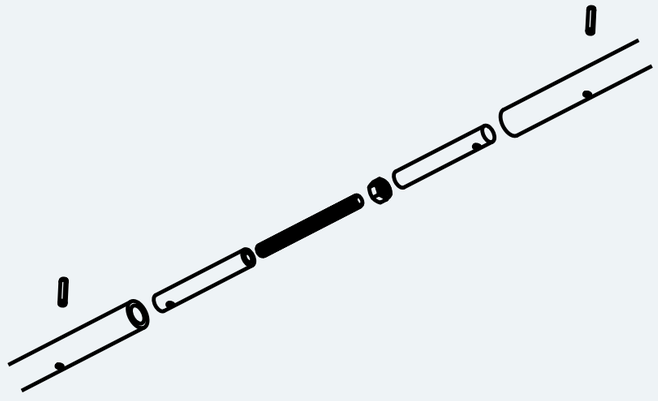
Users can gain access to the pulley system components by **removing the inner rigid ETFE panelling** secured by acetal wing head quarter turn fasteners.

Yearly servicing will be carried out by the contracted installers to prolong product lifetime and perform any larger repairs.

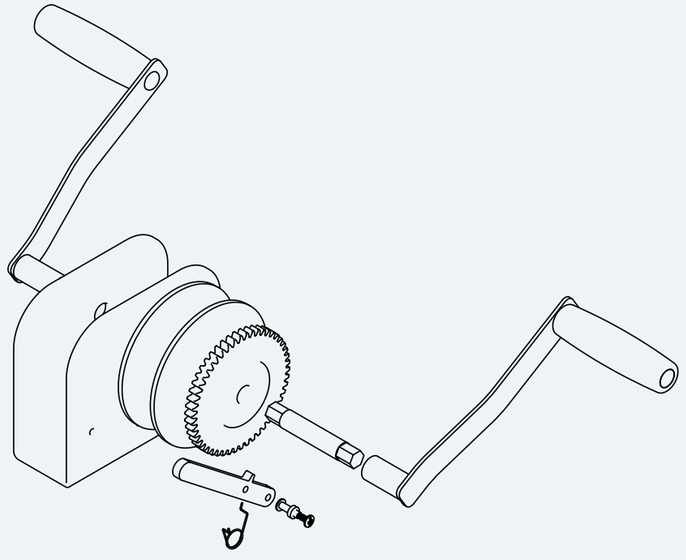
Assembly



Hoop Hinge Sub-Assembly

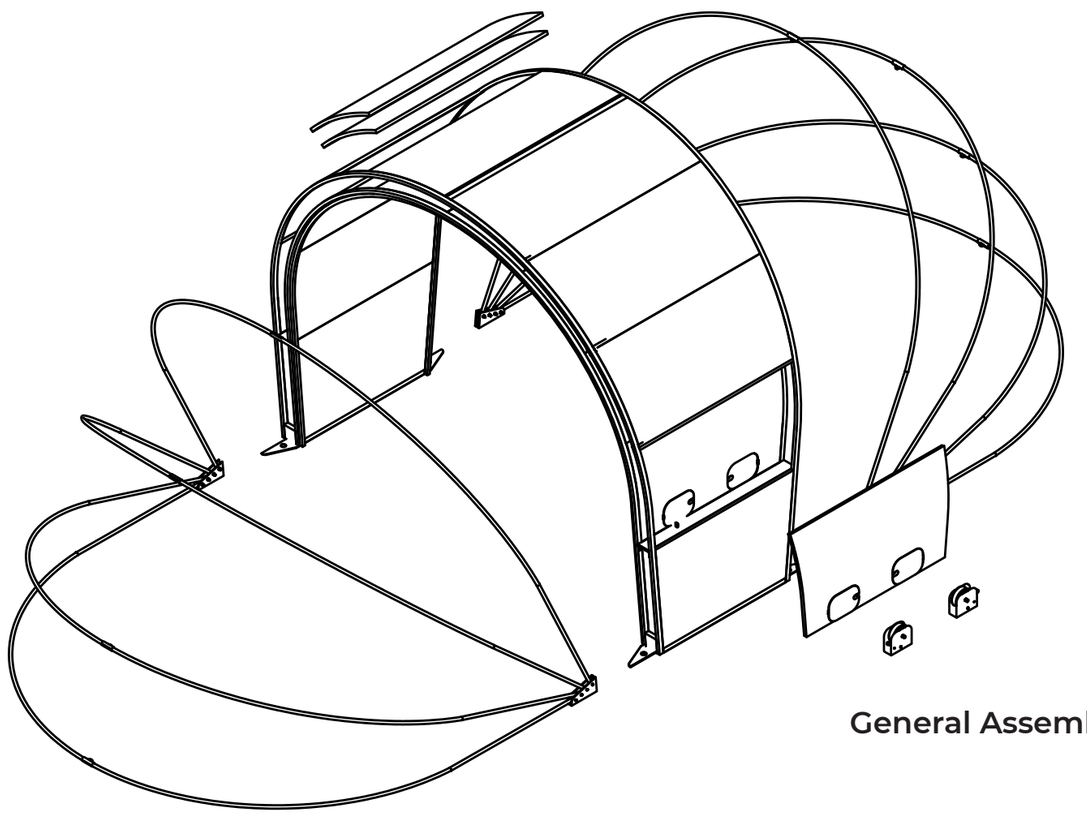


Hoop Connectors



Winch Sub-Assembly

Exploded views of selected component sub-assemblies critical to product operation



General Assembly