KNITTED ORCHARDS

**The concept**

Our project took as a reference the Kleingartens in order to provide a space-based on the exploration and experimentation of natural connections. Where the design of an innovative public greenhouse will let people integrate and create collaboratively its natural environment, finding their creative side while learning about horticulture and sustainable energies.

These new experiences entering the garden are based on a variety of living corridors which give the public the ability to create functional patterns, planting from a different list of local vegetables, fruits, and flowers. In addition, the structure provides event spaces perfect for public lectures or places for art installations and plant exhibitions.

**The context**

Key aspects to analyze were the green corridor which projects the connection of fragmented spaces of Mannheim into a large green space and analyze the Spinelli Park as a freedom and movement place which gives new possibilities for rethinking the former military areas as an open space with natural spatial diversity.

A significant part of this strategy involves site connection of urban attractions creating a network of urban gardens in the surrounding areas of Spinelli Park such as Wilde-Au, Sellweiden, and Wallstadt. With specific zones like the Climatepark, Themed Gardens, and U-hall Spaces that are already taking part in the frame concept proposed for the BUGA 23.

**Technology and strategies used**

**-** Modular assembly concept

- Dew condensation and collection

- Water guiding organic surface

- Solar energy generation

- Crops harvesting

**Social co-benefits of our design and sustainable development goals**

The pattern of Pocket weaves on inner surfaces provides enclosures for seeds that people can interact with, and discover the essential horticulture processes. **(4 quality education)**

The organic flowing nature of the form allows interior exploration by accessing different platforms and will allow the users to observe Mannheim and Spinelli Park from various perspectives. (15 life on land)

Generating and storing renewable energy for small-scale urban needs, integrating textiles with the Flexible Solar Knit located on the top of the modules. **(7 affordable and clean energy)**

The urban garden modular approach could be scaled and replicated when needed.

(**11 sustainable cities and communities ) (2 zero Hunger)**

**Modularity**

Our Initial idea was to create a unified unit system that can be merged with neighboring units, after researching the Modularity of minimal surfaces the simplified version of the batwing minimal surface was the most suitable for our goal as it allow for a seamless connection while maintaining rotation of 90°, creating a variation of option and spaces with each rotation.

As each unit is composed from 12 identical quarter arcs, this makes the fabrication much more cost efficient.

**Used materials**

The structure comprises three main components.

The center piece is a CNC knitted mesh material made from high-strength polyester yarn.

The shape of the canvas is given by the aluminum pipes that hold the textile in points placed along its edges.

A crimping method will be utilized for joining the pipes with PVC corner units that are fixed in place around the circumference in order to avoid the chemical corrosion that can occur between the pieces.

**Plant selection**

The selected crops are a combination of water purifying and fruit producing plants that are typically found in the area of Baden-Württemberg. The plants are placed in accordance with their function, water needs and growth style in order to increase their efficiency (herbs that filter the water are placed on top of the structure followed by the fruit and vegetable crops on the way down).

**Pocket creation**

Given the fact that the entire fabric structure will be manufactured using a knitting to shape CNC machine, a double/multilayer knitting technique will be used for the pocket creation which will be later filled with a clay aggregate that will facilitate the crop growth without the need of soil. This system will help reduce the weight that the knit structure has to withstand while also providing a couple of advantages from an agricultural standpoint.

First of all, the margin for error for over or under-watering the plants is greater. The abundant air present in the clay aggregate enables a stronger root system that is also more forgiving if over-watered.

The length of time in between watering cycles is also increased, typically tripled compared to the soil alternative.

**Water gathering**

Our project will rely on exploiting the physical processes responsible for the dew formation phenomenon to collect water without the need of additional energy input and use with the scope of crop irrigation.

By implementing a black and white gradient for our fabric that is brightening from top to bottom we are aiming to utilize the high emittance of the darker area to enhance night time cooling of the surface, therefore increasing the efficiency of the dew generating process.

The accumulated water will slide down on the fabric until it reaches the pipe system that will distribute it to the pockets hosting the plants.

**Solar analysis**

The solar energy will be captured using a novel and sustainable energy solution in the form of a photovoltaic fabric that can deliver a reliable amount of energy that will be stored in batteries situated in the interior of the structure and serve as charging stations for devices ranging from mobile phones to electrical scooters.

The solar fabric was woven using the electronic yarns created by embedding miniature sized crystalline silicon solar cells connected with fine copper wires within the fibers of a textile yarn. This method of integrating solar energy harvesting capability within the core of the textile fabric allows it to retain the flexibility and the three-dimensional deformability that will seamlessly integrate onto the structure without interrupting the visual design language.

The solar analysis of our structure revealed that the surfaces that receive the most constant radiation throughout the day are the outer corners. There, the values are ranging from 500 kWh/m2 to 1000 kWh/m2 depending on the inclination of the fabric so it will be the optimal space for capitalizing on the solar exposure by implementing a solar cell embedded yarn fabric.

**Environmental impact**

We started the design process having the environmental influence that our structure will have on the area in mind, therefore the final product proposes a couple of ideas supporting it.

Our modular urban garden approach has a scalable aspect that allows for the structure to be disassembled and replicated in a different location when needed, reusing the same materials thus not producing any kind of waste in the process. Matured plants can be then replanted in the soil where the former structure existed and continue to produce fruit

The planted crops hosted by the covering fabric will provide sustainable food and will introduce its users to a new way of seeing and practicing horticulture.

The assembly will be self-sufficient collecting water and producing its own alternative energy. With a solar cell enhanced fabric area of 170 m2 that has an average efficiency of 13.83% it will result in a 22.19 KW system that can produce **18.28 MWh** annually.