

Project Context 1

Final Report

Mycelium Tent

The biodegradable tent

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Declaration of academic integrity

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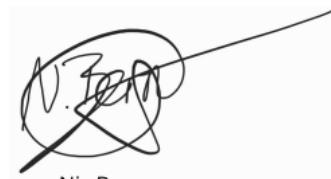
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Abstract

Festivals are significant cultural events but contribute to substantial environmental challenges, particularly through waste generated by abandoned, low-cost tents -often damaged and left behind. These tents are often composed of synthetic materials that are difficult to recycle or dispose of responsibly, exacerbating ecological issues.

This study explores the potential for designing a festival tent that meets user requirements while addressing the environmental impact of single-use camping gear.

Through a value-benefit analysis, mycelium was identified as an optimal material due to its biodegradability, recyclability, and structural viability. The proposed design, the Mycelium Tent, aligns with circular economy principles, offering a fully recyclable and predominantly biodegradable alternative to traditional festival tents.

Although experimental validation under simulated outdoor conditions has not yet been conducted, the material is expected to exhibit adequate water resistance and structural integrity for short-term use. Future testing is required to confirm these properties and refine the material for broader applications.

The Mycelium Tent represents a sustainable, cost-effective solution to reduce festival waste and promote environmentally responsible practices. It emphasizes the potential of mycelium-based materials in advancing renewable and circular design solutions, underscoring the need for further research and development in this field.

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1 Introduction

The environmental challenges posed by global warming have driven society to adopt increasingly eco-friendly practices. However, certain events, such as music festivals, still leave a considerable environmental footprint. Festivals worldwide produce vast amounts of waste, reaching up to 100 tons per day, with abandoned nylon tents being one of the most persistent issue ([Gray reference??](#)). These tents, often made from synthetic materials, are not easily recycled or biodegradable, contributing significantly to plastic pollution that could otherwise be mitigated.

This report focuses on addressing this issue by introducing an innovative solution: a fully recyclable and biodegradable tent made of mycelium. Mycelium, derived from fungal root structures, provides an environmentally friendly alternative to traditional materials, aligning with circular economy principles ([Attias reference??](#)). This project aims to design a tent that meets user needs while reducing waste and improving disposal options at the end of its life cycle.

This report presents this project in its developmental stages. Section 2 explores the properties and potential of mycelium for this application. Section 3 outlines the requirements and methodologies, including a morphological box and a value-benefit analysis, used to determine the final design. The resulting product concept is detailed in Section 4, followed by its validation and testing, discussed in Section 5. Lastly, Section 6 concludes by evaluating the success of the project and identifying opportunities for future improvements.

2 Background

WRITE INTRODUCTION

2.1 Mycelium

The development of the MyceliumTent is focused on replacing existing nylon and plastic tent fabrics with a mycelium-based fabric in order to make it biodegradable.

2.1.1 Definition

Mycelium is the underground root network created by a mushroom organism. Fungi nourish themselves by secreting digestive enzymes to break down organic material in their surroundings and absorb it through the cell walls of the hyphae, their root network (Ahmadjian et al., 2024). Various types of fungi produce mycelium. For this project, the focus is on a fungus with a high growth rate, suitable for the production of biocomposites. In this case, it is possible to use the oyster mushroom (Nicolcioiu et al., 2016)

3 Development of concept

This chapter describes the development of the concept of Mycelium Tent. The user scenario is presented at the beginning. From it, a catalogue of requirements is made, and the result of this section is the concept for the final product.

3.1 User scenario

This sub-section explains the primary use case of Mycelium Tent and what describes the problem it is going to solve.

3.1.1 Problem

Many festival-goers buy cheap, disposable tents with the intent to use them only once. These tents are often left behind after the event, as they are difficult to carry back, especially if they are damaged. Because festivals can be rough on tents, people are reluctant to bring high-quality ones and instead opt for cheap alternatives. As a result, thousands of plastic and nylon tents are abandoned after major festivals, creating an environmental issue with large amounts of non-biodegradable waste.

3.1.2 Objective

The Mycelium Tent is a biodegradable and recyclable tent made from mushroom roots, designed as an eco-friendly alternative to single-use plastic tents often abandoned at festivals and outdoor events. Lightweight, easy to carry, and affordable, it provides a durable yet temporary shelter that helps reduce plastic waste and minimize environmental impact, offering festival-goers a sustainable way to enjoy their experience without contributing to pollution.

3.2 Requirements catalogue

Based on the final user scenario and the feedback of potential customers, the requirements have been defined in the catalogue of requirements (Table 1).

Table 1: Catalogue of requirements

Nr.	Mandatory / Optional	Category	Topic, questions	Requirement
Functional requirements				
1	M	Main function	What is the primary application of the product from the customer point of view?	To keep the customer and the customers belongings dry and clean during a festival.
2	M	Actors	Who buys the product? Who uses the product?	Buyers B2C: Festival-goers Users: Festival-goers, typically between the ages of 18 and 35.
3	O 3	Actors	What other potential customers are conceivable?	B2B: Corporation with Festival-organizers (Tent-Inclusive offer)
4	O 5	Start process	How to set up or start up the installation?	Self-explanatory set-up
5	M	Dimensions	What is the maximum/minimum dimensions of the product?	Max. length: 60 cm Max. diameter: 20 cm
6	M	Weight	What is the maximum weight of the product?	Max. 5 kg.
7	M	Sustainability	How big is the environmental impact of the tent?	80 % by mass of the tent is recyclable.
Non-functional requirements				
8	M	Costs	What should the product cost from the user's perspective?	30 to max. 80 CHF
9	O 4	Durability / quality	How long should the product last when used properly? How susceptible to faults should the product be at most? What stresses can the product withstand?	The product should last for 5 days, the duration of a long festival. The tent should be able to withstand a wind force of 50 km/h. (Beaufort scale 6)
10	O 4	Design	Color? Shape?	The Design should be puristic, simple and should be offered in a variety of bright colors.
11	M	Operability	Simple handling	Easy to set up (within 10 min)
12	M	Safety	Special safety measures	The Tent must be fully fireproof and have a minimum hydrostatic head of 1500 mm.
13	M	Legal norms / standards	e.g., road-safety laws, CE-Norm	DIN EN ISO 5912 (Waterproofness, tear resistance) DIN 4102 B1 (flame retardant)

3.3 Morphological box

This chapter describes the process of developing three design variants for a biodegradable festival tent using the morphological box method. The product was divided into key subproblems, such as shape, size, structure support, lifespan, and material processing. For each subproblem, a range of possible solutions was researched, resulting in the initial morphological box (section 10, Table 8).

To streamline the process, less critical subfunctions, like color design and biodegradation duration, were excluded, and unsuitable materials, such as unprocessed Mycelium-Based Composites (MBCs) and plastic, were removed. The refined morphological box (section 10, Table 9) formed the foundation for selecting three promising design variants, which are detailed in Table 2 and the following section.

Table 2: Morphological box with three solution variants

Sub-Functions / Problems	Solution 1	Solution 2	Solution 3	Solution 4
Shape	Right triangular prism	Dome	Tunnel	Instant-tent (Decathlon-Style)
Size (People)	Max. 1 p.	Max. 2 p.	Max. 3 p.	Max. 4 p.
Structure support	Mycelium-poles	Aluminum	Bamboo	
Lifespan	Single use	5 months	1 - 3 years	
Quality	Low	Medium	High	
Processing Method	Mycelium-based Leather MBL		Kombucha leather	

3.3.1 Description of the three solution variants

Variant 1: Dome tent (Single use, Fully biodegradable)

The first variant is a dome-shaped tent, constructed entirely from biodegradable materials, including mycelium poles and Mycelium-Based Leather (MBL). This variant is designed for single-use and aims to provide the highest possible grade of biodegradability. It is produced with a focus on low-cost and low-quality materials, suitable for short-term use at festivals.

Variant 2: Tunner tent (Four-person, Long-lasting)

The second variant is a tunnel tent, chosen for its optimal space-to-weight ratio, making it suitable for accommodating four people—the largest capacity in this selection. It is designed with higher-quality materials for a lifespan of one to three years, supported by an aluminum structure for enhanced durability and stability.

Variant 3: Triangular prism tent (Two-person, Medium-lasting)

The third variant is a right triangular prism-shaped tent, designed for two people. This option combines features from both the high-quality tunnel tent and the single-use dome tent. It uses bamboo poles, which provide greater longevity than mycelium but are less durable than aluminum, while still maintaining biodegradability.

The final selection between these three variants will be made in the following chapter.

3.4 Value-Benefit analysis

Table 3 presents the Value-Benefit analysis of the three previously described tent variants. In alignment with our primary objective of addressing plastic waste at festivals, recyclability is assigned the highest priority. The affordability of each variant is also crucial, as it must remain competitive with existing products that contribute to the plastic waste problem. Given that the target market is festival-goers seeking short-term, disposable solutions, the overall quality and lifespan of the tents are less critical, as we do not aim to compete in the high-quality tent market.

The analysis includes a row for “Weather Resistance”, which evaluates the tent’s ability to endure adverse weather conditions, such as heavy winds. This aspect is particularly relevant as different shapes provide varying levels of structural resilience.

Table 3: Value-Benefit analysis

Criteria	Weighting	Dome		Tunnel		Prism	
		Score	Weighted score	Score	Weighted score	Score	Weighted score
Price	25	8	200	2	50	6	150
Recyclability	25	9	225	5	125	7	175
Handling	15	6	90	5	75	6	90
Lifespan	10	3	30	8	80	6	60
Quality	10	3	30	8	80	6	60
Weather resistance	15	7	105	7	105	5	75
TOTAL Score			680		515		610

3.4.1 Justified choice

Based on the weighted ratings derived from the Value-Benefit analysis Table 3, the Dome Tent variant emerges as the most suitable option, achieving a total score of 680 points, the highest among all variants. This reflects its strong alignment with customer requirements, such as affordability, ease of use, and reduced environmental impact, making it particularly appealing to festival-goers. Its features address key customer needs for sustainable temporary shelter, while effectively contributing to the goal of reducing plastic waste in festival environments.

4 Final concept

This chapter presents the finalized Mycelium Tent design, detailing its structure, key features, and components. It provides technical specifications based on the concept and includes plans and diagrams for fabrication and assembly.

4.1 Product concept

This section presents an overview of the Mycelium Tent, detailing its features with labeled images of a simplified model that illustrates the structure and key components.

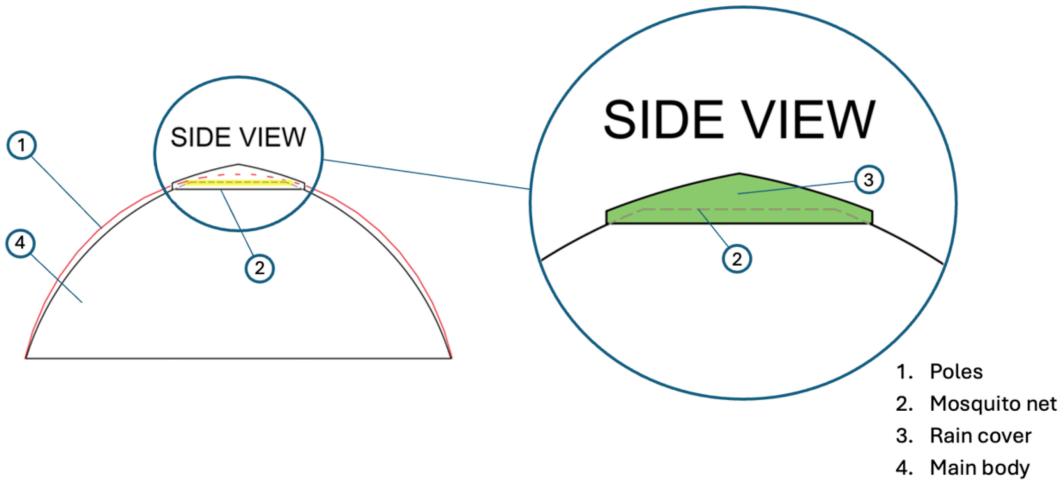
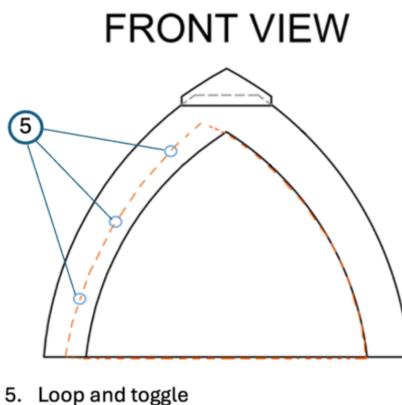


Figure 1: Details side view

The main body of the tent is fully enclosed, extending up to the top, where an opening with a protective mosquito net ensures constant air circulation. This ventilation opening is safeguarded by a rain cover to prevent water ingress while allowing airflow. To maintain an optimal space between the tent body and the rain cover, the tent poles are positioned externally, supporting the rain cover above the body. This structure is depicted in Figure 1



5. Loop and toggle

Figure 2: Details side view

Entry to the tent is facilitated by a secure loop-and-toggle system. Additionally, the door features an overlapping design to prevent rain from entering the tent, as shown by the orange line in Figure 2. These specifications are based on the features layed out in the conception of product

4.2 Technical specifications

The technical specifications display the list of the main components such as size and material in Table 4. These specifications are based on the features layed out in the conception of product section 4 and the morphological box. The scale for the prototype was set to 1:10.

The intention of the single use tent translates into biodegradable tent materials. However, this criteria for the accessories shown in Table 4 cannot be fulfilled at this stage of development.

Table 4: Technical specifications

Description	Material	Size in cm	Pieces	Notes
Bottom part	Mylo leather	215 x 215	1	Floor plan +30cm
Poles	Mycelium	324	2	
Rain cover	Mylo leather	65 x 65	1	
Cover (main body)	Mylo leather	185 x 150	4	
Latch	Cotton			Velcro has no biodegradable product on the market yet
Rope / cord	Jute	200	2	
Perforated net	Mycelium mash	ø65	1	
Accessories				
Peg	Aluminium		8	

4.3 Construction plans

The construction plans show in detail the shape and size of the tent. The final product will be based on these technical plans, as well as its components will depend on them. The tent consists of two main elements: the tent itself and the airtight cap.

The structure of the Mycelium Tent is made of mycelium, as is the access door. Its base measures (LxW) 185x185 cm, while the height from the base to the highest point (H) is 140 cm as shown in section 10, Figure 5 (Tent size).

It has a central circular hole on the highest part, which promotes optimal air exchange and the passage of natural light.

Together with the circular hole, a fine mycelium perforated net is provided to supply protection against all kinds of insects. It is also designed to facilitate night vision for starry sky observers.

The airtight cap is also made of mycelium. Its main feature is that it is mountable at any time and serves to prevent water or too much sun from entering the interior of the tent. The cap is also raised to always ensure air exchange inside the tent.

The dimensions of the circular cap are $\varnothing 60\text{cm}$, and circumference 188.5 cm as shown in section 10, Figure 5 (Tent size). The cap is placed on the tent pegs and tied to them.

The Mycelium Tent with the mounted cap measures (LxWxH) 185x185x150 cm.

5 Mock-up

The mock-up presentation is a key part of the project, allowing users to visualize and understand the tent's design. The tent's features, including the removable cap and door operation with the respective materials used to create the mock-up, will be shown below.

5.1 Concept of mock-up

The Mycelium Tent mock-up features a fully enclosed body with an upper ventilation opening, protected by a mosquito net and a rain cover. External poles ensure airflow and prevent water ingress. The entry is secured with a roll-and-button system, and the overlapping door design blocks rain (Figure 3). The mock-up has dimensions (LxWxH) 17.5x17.5x14 cm.

At the time the mock-up was created, the scale corresponded precisely to 1:10 of the final tent, before the base of it was resized. The model, with the final version of the tent, is not to scale, as can be seen at section 10, Figure 6 (Mockup size).

The final product will be constructed from mycelium, with a sample material displayed alongside the mock-up (Figure 4). Following the initial draft of the mock-up, design adjustments were made to enhance the tent's shape and functionality. As a basis, a simple construction plan is used to build and set-up the mock-up. Following materials and sources are part of the mock-up:

- Cotton textiles for the rain cover and the main body;
- Bronze metal string for the framing;
- Mesh material as the mosquito net.



Figure 3: Final mock-up



Figure 4: Sample of compact mycelium

6 Testing

This chapter examines the testing phase, which is critical to ensuring that the product meets technical specifications and fulfils customer requirements. The expected results are then evaluated to give clarification, if further tests or development is necessary.

6.1 Tests

The testing process is divided into two principal areas: Verification and Validation. For each area, three different tests will be conducted.

6.1.1 Verification

This subchapter discusses the verification process during the testing phase. The purpose of this process is to ensure that the product has been developed correctly and meets the predefined requirements. Three of the most significant tests are outlined in Table 5, with the numbers in brackets indicating the corresponding links to the requirements catalogue (Table 1).

Table 5: Verification tests

Function	Requirement	Test procedure	Expected Result
Hydrostatic head (1/12)	The tent should have a minimum hydrostatic head of 1500 mm	The hydrostatic head is determined by a water pressure test. The material is subjected to increasing water pressure. This continues until the material allows water to pass through. When the third drop has penetrated to the inside, the test ends.	The height of the water column at the point of water passage is above 1500 mm. ⇒ Fulfilled
Wind resistance (9)	The tent should be able to withstand a wind force of 50 km/h (Beaufort scale 6).	The tent is set up on a meadow and tested with a wind generator simulating a wind speed of 50 km/h for 30 minutes. Inside, it contains a sleeping bag, sleeping mat, and backpack with a total weight of 8 kg. The meadow has a minimum soil moisture of 40%, reflecting conditions after rainfall. This worst-case scenario eliminates the need for additional tests, as drier conditions improve results.	The tent remains in place for half an hour. ⇒ Fulfilled
Air circulation (1)	It is not only the waterproofness that determines whether it stays dry inside the tent. The geometry of the tent must allow the humidity to be transported outside.	A humidifier is placed in the tent and switched on for 8 hours. It is set to release 50 ml of water per hour, which is roughly equivalent to a human being breathing. At the same time, the wind generator is set to 20 km/h to simulate a realistic wind situation on a large field.	No water collects on the tent floor after 8 hours: ⇒ Fulfilled

6.1.2 Validation

This subchapter outlines the validation process, which involves three key tests (Table 6) to determine whether the correct product has been developed and whether it fulfills customer requirements as specified in the requirements catalog. The aspects evaluated include the operability, sustainability, and durability of the tent during a festival. As all requirements are mandatory, each test must be successfully validated to ensure compliance.

Table 6: Validation tests

Function	Requirement	Test procedure	Expected Result
Operability (4/11)	The set-up of the tent should be self-explanatory and fully constructed in 10 minutes.	20 subjects aged between 18 and 35, who have no physical impairments and no previous experience of setting up tents, each get 10 minutes to completely set up the tent. The only aid they are given is a construction manual, with a visual and written demonstration of the set-up process.	All 20 subjects are expected to fully set up the tent within the given timeframe. ⇒ Fulfilled
Sustainability (7)	80% of the mass of the tent should be recyclable.	The mass of the recyclable parts of the tent are added and compared to the tent's complete mass to determine the percentage of the recyclable material.	Due to insufficient details on the density of mycelium-based leather only an assumption can be made. However, considering the fact, that the only non-recyclable components are the pegs, it is expected that more than 80% of the total mass of the tent is recyclable. ⇒ Fulfilled
Durability during a Festival (1)	The tent should keep the customers and their belongings dry and clean.	During a five-day festival, the tent will be put to normal use by a subject in a simulation of the unexpected incidents or weather changes than can appear during a festival. The test will be conducted during a period, when rain is guaranteed. Therefore, if a festival concludes with no rainfall, the test shall be repeated at a different festival. This process will be repeated until rainfall has occurred.	The tent is expected to withstand the five day festival and keep the belongings and the subject themselves dry and clean. ⇒ Fulfilled

The use of the fully developed mycelium-based material is crucial for the tests outlined in this subchapter discusses the verification process during the testing phase. The purpose of this process is to ensure that the product has been developed correctly and meets the predefined requirements.

Three of the most significant tests are outlined in Table 5, with the numbers in brackets indicating the corresponding links to the requirements . Therefore, these tests cannot be conducted using a mock-up, as it does not accurately represent the properties and behaviour of the material in its final form. Instead, they must be carried out using the first prototype, which incorporates the fully developed material. This approach ensures that the material performance, durability, and sustainability can be assessed in real-world conditions, providing reliable data for further development and refinement of the product.

6.2 Discussion

Regarding the verification tests, the primary source of uncertainty lies in the water resistance of the material, particularly its water column. Existing materials with adequate water resistance, such as alternatives to rubber seals, demonstrate that it is feasible to produce a mycelium-based material with similar properties. However, further testing is required to determine whether the material maintains its water resistance at very thin wall thicknesses, which is crucial for meeting weight specifications.

Wind resistance is unlikely to pose a significant challenge due to the aerodynamic, wind-slip shape of the tent. However, the ability to effectively manage moisture inside the tent remains a concern. As this is a single-wall design, the construction and shape of the tent play a critical role in facilitating ventilation. To address this, the ventilation opening has been enlarged relative to the tent's total surface area. The effectiveness of this design will only become clear during prototype testing.

Like the wind resistance, the validated operability and sustainability are unlikely to cause later complications. This is due to the facts that the tent not only has a simple structure and a construction manual as an available aid for the set-up process but is also made predominantly out of a recyclable and biodegradable material. The overall durability of the tent during a festival on the other hand could lead to further concern. Additional tests during extended festivals with varying weather conditions will need to be performed to clarify how well the tent can withstand longer and more challenging conditions.

7 Conclusion

The MyceliumTent project has sought to approach the critical environmental issue of waste accumulation at festivals by developing a tent composed of a fully sustainable and recyclable material. Mycelium, characterized by its high recyclability and cost-efficient cultivation, has shown promise as a potential solution. However, a key challenge remains the evaluation of its suitability as a tent material. Addressing this challenge requires extensive research and development, which falls beyond the scope of this project.

Despite these challenges, the concept has demonstrated substantial potential. It responds an urgent environmental problem and offers a compelling business opportunity, particularly as a B2B solution for festival operators. Collaborations with such stakeholders could significantly enhance the project's impact and feasibility.

Future work should prioritize comprehensive research into the material properties of mycelium, followed by the production and evaluation of prototypes under realistic conditions. This iterative development process will enable the refinement of the product to ensure its functionality and durability. Given the significance of the problem and the potential of the proposed solution, continuation of this project is strongly recommended.

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9 Declarations on the use of AI tools

- *DeepL* and *ChatGPT 4o* have been used as a spell-checker;
<https://www.deepl.com/>
<https://www.chatgpt.com/>

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10 Appendix

Table 7: Appendix table

Nr.	Mandatory / Optional	Category	Topic, questions	Requirement
Functional requirements				
1	M	Main function	What is the primary application of the product from the customer point of view?	To keep the customer and the customers belongings dry and clean during a festival.
2	M	Actors	Who buys the product? Who uses the product?	Buyers B2C: <u>Festival-goers</u> Users: <u>Festival-goers</u> , typically between the ages of 18 and 35.
3	O 3	Actors	What other potential customers are conceivable?	B2B: Corporation with Festival-organizers (Tent-Inclusive offer)
4	O 5	Start process	How to set up or start up the installation?	Self-explanatory set-up
5	M	Dimensions	What is the maximum/minimum dimensions of the product?	Max. length: 60 cm Max. diameter: 20 cm
6	M	Weight	What is the maximum weight of the product?	Max. 5 kg.
7	M	Sustainability	How big is the environmental impact of the tent?	80 % by mass of the tent is recyclable.
Non-functional requirements				
8	M	Costs	What should the product cost from the user's perspective?	30 to max. 80 CHF
9	O 4	Durability / quality	How long should the product last when used properly? How susceptible to faults should the product be at most? What stresses can the product withstand?	The product should last for 5 days, the duration of a long festival. The tent should be able to withstand a wind force of 50 km/h. (Beaufort scale 6)
10	O 4	Design	Color? Shape?	The Design should be puristic, simple and should be offered in a variety of bright colors.
11	M	Operability	Simple handling	Easy to set up (within 10 min)
12	M	Safety	Special safety measures	The Tent must be fully fireproof and have a minimum hydrostatic head of 1500 mm.
13	M	Legal norms / standards	e.g., road-safety laws, CE-Norm	DIN EN ISO 5912 (Waterproofness, tear resistance) DIN 4102 B1 (flame retardant)

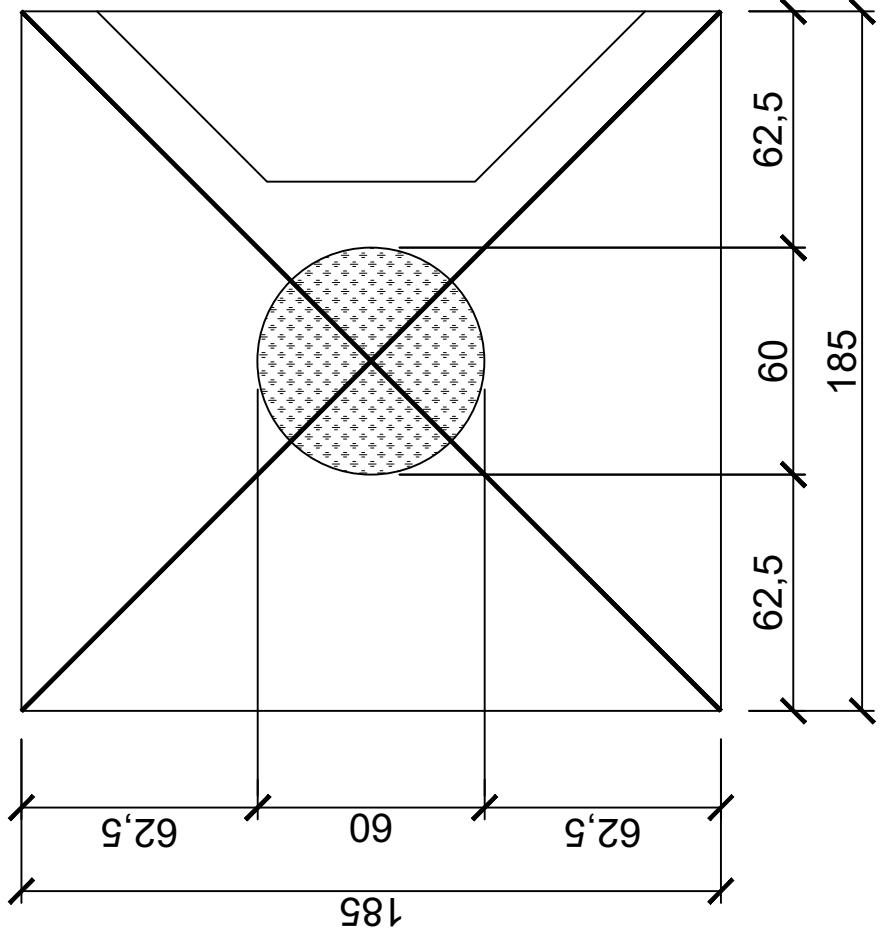
Table 8: Initial morphological box

Sub-Functions / Problems	Solution 1	Solution 2	Solution 3	Solution 4
Shape	Right triangular prism	Dome	Tunnel	Instant-tent (Decathlon-Style)
Size (People)	Max. 1 p.	Max. 2 p.	Max. 3 p.	Max. 4 p.
Design	Single color	Multiple colors		
Structure support	Mycelium-poles	Aluminum	Bamboo	Plastic
Lifespan	Single use	5 months	1 - 3 years	
Quality	Low	Medium	High	
Processing Method	Mycelium-based Leather MBL	Unprocessed MBC	Kombucha leather	
Duration of Biodegradation	1-2 months	3-12 months	1-3 years	

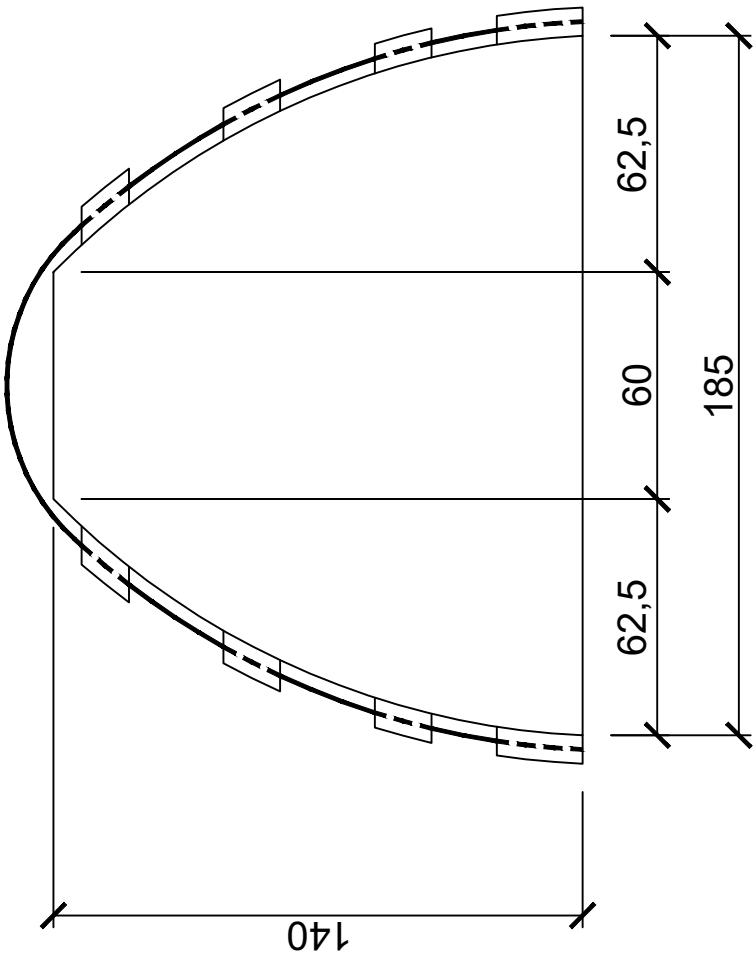
Table 9: Slimmed-down morphological box

Sub-Functions / Problems	Solution 1	Solution 2	Solution 3	Solution 4
Shape	Right triangular prism	Dome	Tunnel	Instant-tent (Decathlon-Style)
Size (People)	Max. 1 p.	Max. 2 p.	Max. 3 p.	Max. 4 p.
Design	Single color	Multiple colors		
Structure support	Mycelium-poles	Aluminum	Bamboo	Plastic
Lifespan	Single use	5 months	1 - 3 years	
Quality	Low	Medium	High	
Processing Method	Mycelium-based Leather MBL	Unprocessed MBC	Kombucha leather	
Duration of Biodegradation	1-2 months	3-12 months	1-3 years	

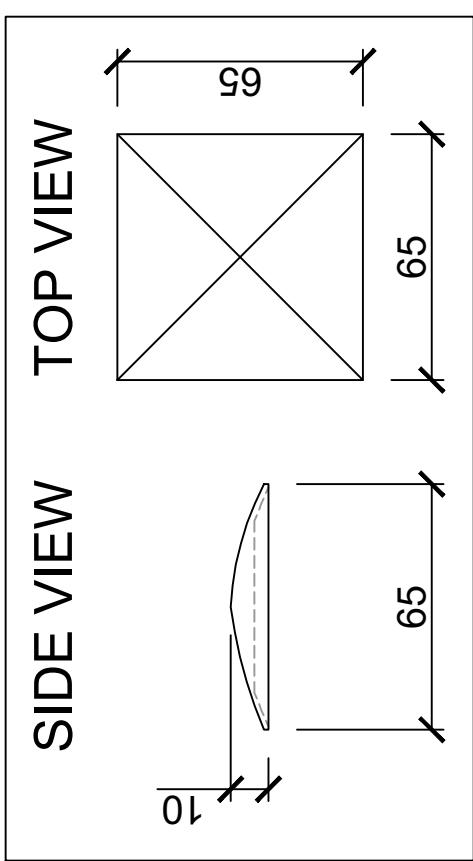
TOP VIEW



SIDE VIEW



REMOVABLE CAP VIEWS



drawing in cm

MYcellum TENT SIZES **HSLU Hochschule Luzern**

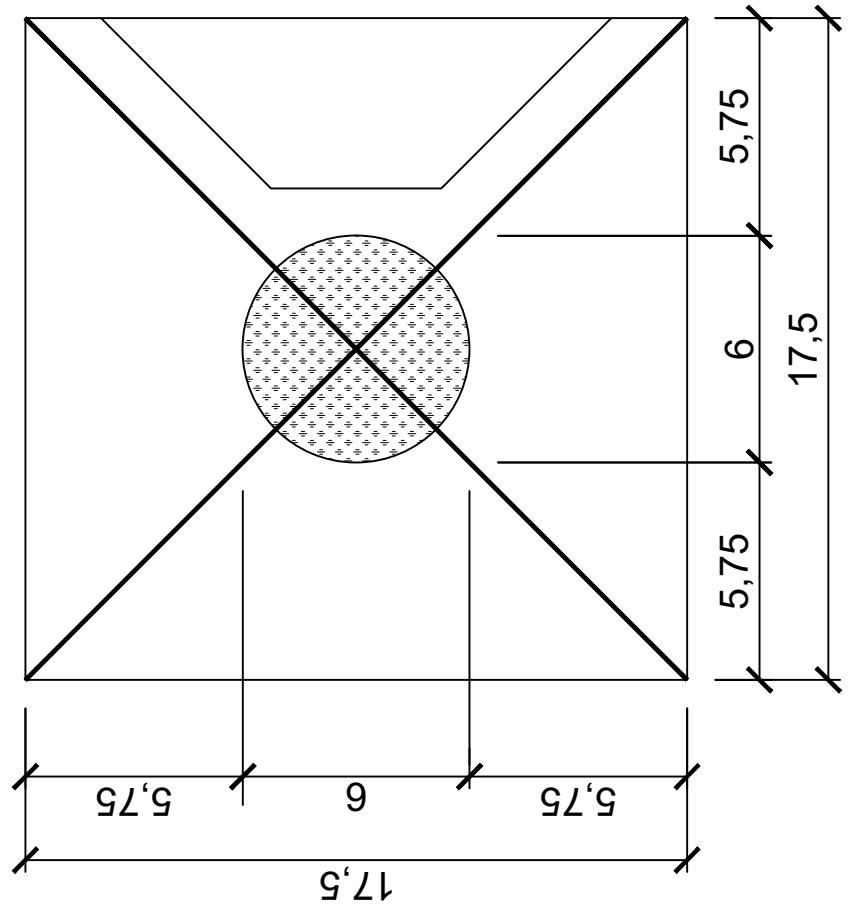
Team: 31 Version: v3 - tent and cap sizes

Author: Matteo Frongillo Scale: 1:20

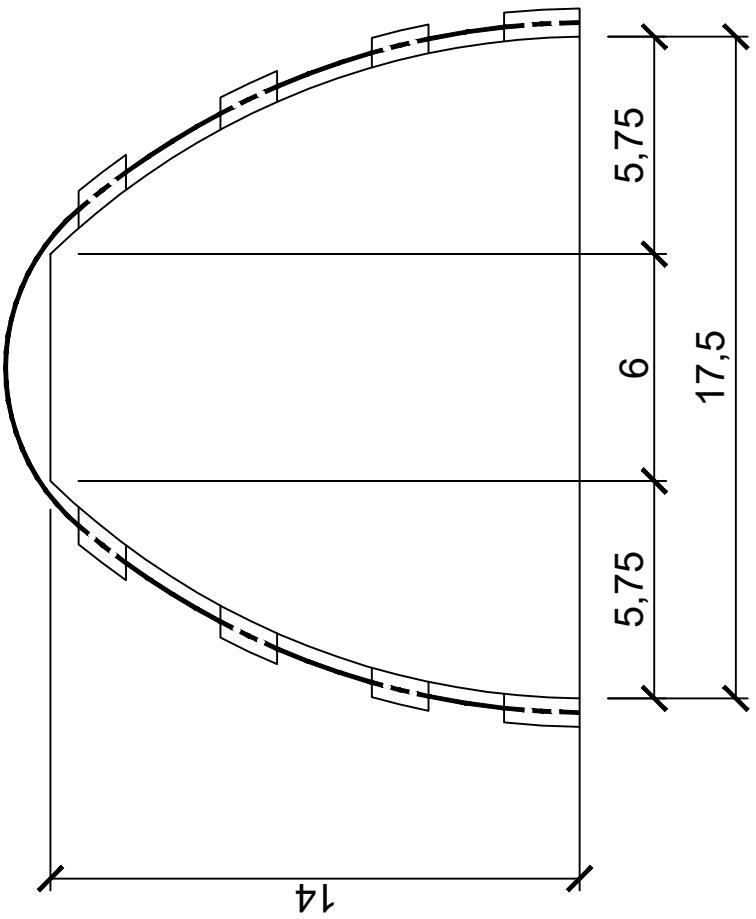
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Module: Context 1 Date: 08.12.2024

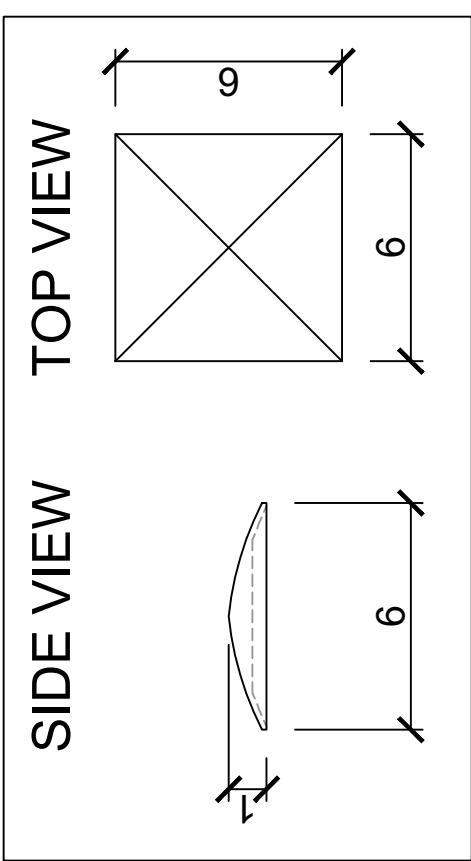
TOP VIEW



SIDE VIEW



REMOVABLE CAP VIEWS



drawing in cm

MY celium TENT MOCKUP **HSLU Hochschule Luzern**

Team:	31	Version:	v3 - mock-up sizes
Author:	Matteo Frongillo	Scale:	1:2
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Module:	Context 1	Date:	06.12.2024