Project Context 1

Final Report

My$_{\text{celium}}$Tent

The biodegradable tent

Team 31

Althaus Simon
Berner Nic
Frongillo Matteo
McCarthy Benjamin
Nyamdorj Narandavaa

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Team 31

Name	Field of studies	E-mail
Althaus Simon	Business engineering	simon.althaus@stud.hslu.ch
Berner Nic	Energy and environmental systems engineering	nic.berner@stud.hslu.ch
Frongillo Matteo	Energy and environmental systems engineering	matteo.frongillo@stud.hslu.ch
McCarthy Benjamin	Medical engineering | Life sciences	benjamin.mccarthy@stud.hslu.ch
Nyamdorj Narandavaa	Business engineering	narandavaa.nyamdorj@stud.hslu.ch

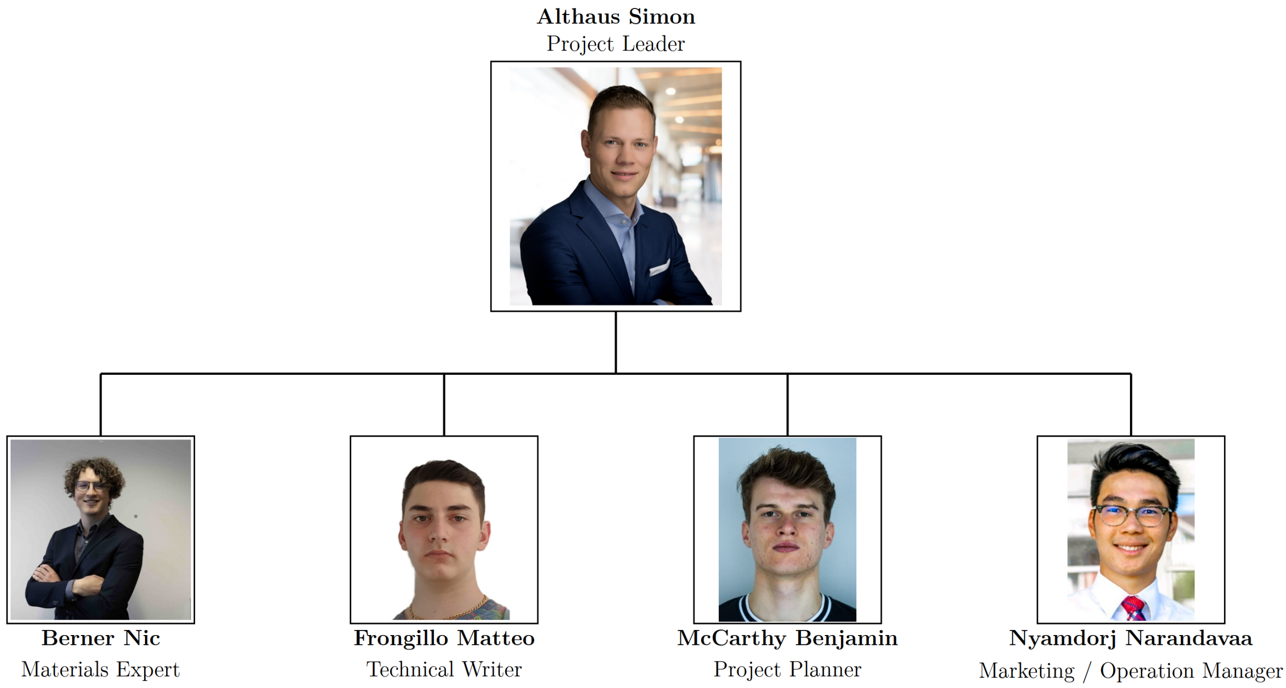

Figure 1: Organisational chart

Declaration of academic integrity

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Date / Location:

18th December 2024, Horw

Signatures:

Benjamin McCarthy

Simon Althaus

Matteo Frongillo

Narandavaa Nyamdorj

Nic Berner

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 usually 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 My$_{\text{celium}}$Tent, aligns with circular economic 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 My$_{\text{celium}}$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.

Contents

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, 2019). 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 biodegradable and mostly recyclable tent made of mycelium. Mycelium, derived from fungal root structures, provides an environmentally friendly alternative to traditional materials, aligning with circular economy principles (Abitbol et al., 2020). 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 the project in its developmental stages. Section 2 explores the properties and potential of mycelium for the described 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

This section provides the essential background for the project, focusing on mycelium as a sustainable material for tent construction. It examines its properties, potential applications, and environmental benefits, alongside an analysis of tent structures, market trends, and safety requirements. This foundation supports the development of the $\mathrm{My}_{\mathrm{celium}}$Tent as an eco-friendly and functional solution.

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 recyclable.

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).

2.1.2 Potential of mycelium

The potential of this material lies in its low carbon footprint, low energy and processing cost, and biodegradability. The most common use cases in the industry so far include leather, packaging materials, or composites used for construction. However, challenges remain, such as the lack of standardized treatment methods during material development. This project specifically explores biodegradability, durability, water, and fire resistance, as needed to construct a tent fabric (Ajibuwa et al., 2023).

2.1.3 Mylo leather

Mylo is a product made by the company Bolt Threads, designed as an alternative to animal leather. It is made of a foam-like mycelium (Bolt, n.d.) and is both sustainable and biodegradable. Its durability, waterproofness, and lightweight nature make it a promising material for applications such as tent construction, aligning with eco-friendly design principles.

2.2 Environment

This chapter explores different properties of mycelium bio-composites (MBC), which is the material used in this project. MBCs are "composed of an agricultural residue, a non-living material, colonized by a fungus" (Amziane et al., 2023, p. 740). As of today, the full potential of MBCs has not been found, and different production processes and growth combinations, i.e. types of fungi and substrates continue to be tested and compared.

2.2.1 Mycelium bio-composites

Some important properties for this product are sound absorption, thermal conductivity, and moisture buffering value. These properties vary greatly depending on the substrate-fungus combination. Research on fifty unprocessed MBCs found that the sound absorption coefficient differs from 0.5 to 0.95 depending on the frequency, indicating they are good sound absorbers (Amziane et al., 2023, p.749). The thermal conductivity value was found to be between 0.057 – 0.085 W/(mK), and the mean moisture buffering value was 1.632 (Amziane et al., 2023, p.749). However, no clear values of water resistance were found, although it is possible to coat the MBC in biodegradable polyurethanes or beeswax for extra water resistance and smoothness (Amziane et al., 2023).

2.2.2 Mycelium-base leather

One of the MBC products in use today is mycelium-based leather (MBL). Research has shown that the order of polyporales fungi, specifically Fomitella fraxinea, in combination with a substrate made of sawdust and rice bran, is best suited for the production of MBL. After harvesting, the composites are plasticized (with a biodegradable mixture) and hot-pressed, forming a leather-like material. These processes increase tensile strength, elongation percentage, and reduce water absorption. MBL has a mean tensile strength of 8.49 MPa, can elongate up to 58.86%, and has a water contact angle of up to 129.63°, making it hydrophobic (Kim et al., 2022). Considering these aspects, MBL has the highest potential, of the current known MBC products, to be used for this project.

2.2.3 Biodegradability

Depending on the fungi and substrate used, the biodegradation duration can vary. For example, using Pleurotus ostreatus on a bamboo-based substrate coated with beeswax for increased water resistance shows a mass reduction of 64.13% after two months. However, due to insufficient research on the biodegradability of other MBCs, no definitive information can be provided on the biodegradability of class-sharing fungi like polyporales (Gan et al., 2022).

2.3 Structure and setup

There are several construction options available for tents. To determine the most suitable option for the purposes of this study, this section evaluates the advantages and disadvantages of the most common tent designs. Hilleberg, a manufacturer of high-quality expedition tents, prioritises ease of use, which aligns with the criteria important for the product. Therefore, their approach to tent construction serves as a relevant reference for this analysis. Hilleberg categorizes its tents by label, with the Yellow Label being the most applicable to this project's needs, as these tents are designed for use during snow-free months and in protected environments, or in warmer climates (Hilleberg, 2024b).

The two most common constructions are Tunnel Tents and Dome Tents. Tunnel tents provide the best space-to-weight ratio, making them ideal for mobile journeys where the tent is frequently set up and taken down. Their lighter overall design is advantageous for users who carry their gear during the day. However, tunnel tents are less stable in windy or snowy conditions and typically require pegging to remain upright.

In contrast, dome tents offer greater stability, particularly in adverse weather conditions such as snow or high winds. They are better suited for base camp setups, where they can remain stationary for extended periods. Some dome tents are freestanding, which eliminates the need for pegging and makes them useful in terrains like rocky or gravelly soil. Despite these advantages, dome tents tend to be heavier and provide less space for the weight they add (Hilleberg, 2024a).

In addition to tunnel and dome tents, instant tents represent another construction option that has gained popularity in recent years due to improvements in ease of setup. These tents combine features of both tunnel and dome designs, offering a balance between spaciousness and stability. Instant tents are particularly advantageous for users seeking quick and simple setup, often requiring minimal effort. However, they are generally not designed to withstand harsh environmental conditions such as strong winds or heavy snow, making them more suitable for mild weather and less extreme environments (Outdoor Life, 2024).

2.4 Marketing

The analysis of the marketing of camping tents and outdoor equipment is based on the use of strategies leveraged to reach and engage consumers globally, in Europe, and Switzerland. Nowadays, the use of social media is a key focus for product promotion and customer loyalty through targeted advertising and influencers.

2.4.1 Worldwide market

In 2022, the global camping tent market reached a total value of USD 2.65 billion. The future of this market is positive; in fact, it is set to grow further to USD 4 billion by 2028. This positive outlook is possible due to the increase in outdoor recreation and nature tourism (Expert Market Research, 2023).

2.4.2 European market

According to reported projections, by 2029 the European camping tent market will grow significantly, reaching a value of USD 1.50 billion. The analysis covers various product categories, materials, and capacities, highlighting the increasing demand for innovative and practical solutions in line with new camping trends (Arizton Advisory & Intelligence, 2024).

2.4.3 Swiss market

The analysis of the camping tent market in Switzerland focuses on growth trends driven by increased outdoor activities and investment in sustainable materials. Changes in consumer preferences are also part of the analysis (6Wresearch, 2023).

2.4.4 Marketing strategies

Key marketing strategies for outdoor brands are analyzed based on their impact on their audiences. In fact, content posted on social media is strongly considered, facilitating visibility through influencers, who play a key role in product promotion and customer loyalty (Guest Column, 2024).

2.5 Safety

In the development of a disposable tent, ensuring safety is paramount, particularly for use in crowded and temporary environments such as music festivals. The incorporation of sustainable materials like mycelium necessitates adherence to safety standards, focusing on both mechanical performance and fire protection. These aspects are crucial to safeguard users, mitigate fire-related risks, and offer an eco-friendly solution that minimizes post-use waste.

2.5.1 Fire resistance of mycelium

Mycelium-based composites offer significant advantages in terms of fire resistance, making them well-suited for mass gatherings where the fire hazard is elevated. Compared to synthetic alternatives, mycelium produces less smoke and fewer toxic emissions when exposed to flames, reducing health risks during emergencies. Additionally, the inclusion of silica-rich substrates, such as rice hulls, enhances its fire-retardant properties, ensuring greater protection in densely populated festival settings (Bhat et al., 2018).

2.5.2 Environmental impact and safety

A major benefit of mycelium in the context of this patent is its minimal environmental footprint, both during use and after disposal. Unlike conventional synthetic materials, mycelium composites release negligible amounts of CO2 when combusted. This is especially important for products designed for temporary outdoor use, as it helps limit air pollution and reduces the risk of toxic exposure during unexpected incidents. Moreover, the biodegradable nature of mycelium resolves the issue of waste accumulation post-festival (Hewawasam et al., 2024).

2.5.3 Mechanical safety properties

Myceliums mechanical strength offers another advantage, particularly in ensuring structural stability under varying environmental conditions typical of festivals. The compressive strength and resilience provided by fungal fibers ensure that the tent remains secure and functional throughout its use, offering both physical protection and fire resistance (Aiduang et al., 2024).

2.5.4 Safety in camping applications

For the patent, it is essential to meet established safety regulations for camping shelters, such as the DIN EN ISO 5912:2020 standard, which governs both mechanical and fire safety requirements. The use of mycelium not only satisfies these standards but also adds the benefit of biodegradability, making it an ideal choice for eco-conscious outdoor events. After its lifecycle, the tent naturally decomposes, significantly reducing environmental impact and festival-generated waste (DIN Deutsches Institut für Normung e.V., 2020).

3 Development of concept

This chapter describes the development of the concept of My$_{celium}$Tent. Initially the user scenario is presented and then used to create a catalogue of requirements. With the help of a morphological box and a value-benefit analysis, the result of this chapter is the concept of the final product.

3.1 User scenario

This sub-section explains the primary use case of My$_{celium}$Tent and describes the problem it is going to solve.

3.1.1 Problem

Many festival-goers buy cheap, disposable tents with the intent to only use them 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 My$_{celium}$Tent is a recyclable and mostly biodegradable 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 sustainable 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 9, Table 7).

To streamline the process, less critical subfunctions, like color, design and biodegradation duration, were excluded, and unsuitable materials, such as unprocessed MBCs and plastic, were removed. The refined morphological box (section 9, Table 8) 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: Tunnel 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 the aim is not 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 $\mathrm{My}_{\mathrm{celium}}$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 $\mathrm{My}_{\mathrm{celium}}$Tent, detailing its features with labelled images of a simplified model that illustrates the structure and key components.

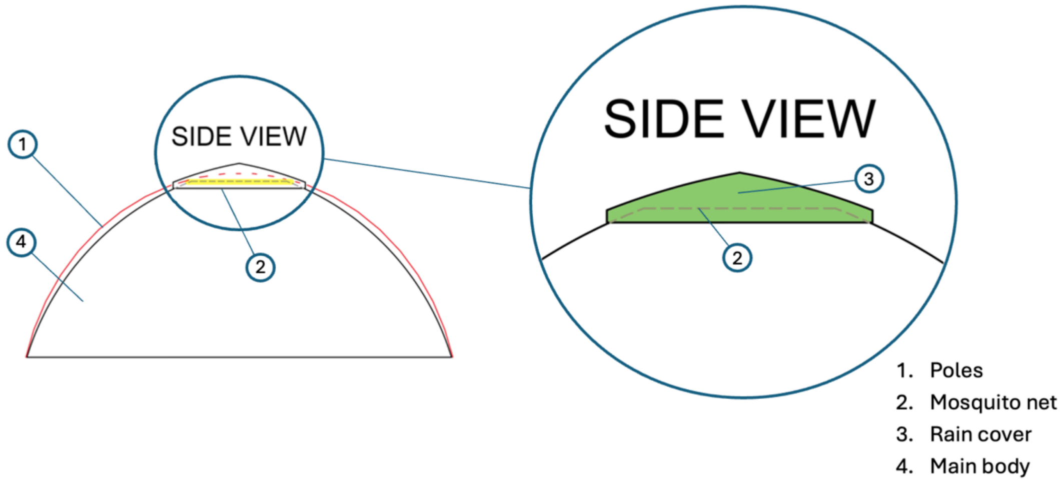

Figure 2: Details side view

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 2

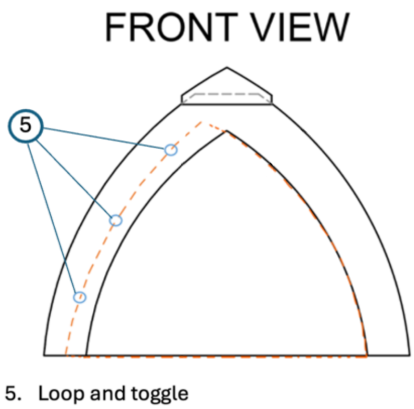

Figure 3: Details side view

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 3.

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 laid out in the conception of product section 4 and the morphological box.

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	⌀65	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 My$_{\text{celium}}$Tent is made from 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 9, Figure 6 (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 from mycelium. Its main feature is that it is mountable at any time and serves to prevent water or too much sunlight 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 ⌀60cm, and circumference 188.5 cm as shown in section 9, Figure 6 (Tent size). The cap is placed on the tent poles and tied to them.

The $\text{My}_{\text{celium}}$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 $\text{My}_{\text{celium}}$Tent mock-up (Figure 4) serves as a scaled-down representation of the full-size product, designed to demonstrate its key features in a compact form. With dimensions of (LxWxH) 17.5x17.5x14 cm, the mock-up reflects the core functional and structural elements of the actual tent, offering a conceptual demonstration of its design principles.

5.1.1 Key featues

The mock-up includes a fully enclosed body that replicates the real product's upper ventilation system, integrating a mosquito net and a rain cover to demonstrate airflow and protective design. Similar to the actual product, the tent poles are positioned externally, outside the main body and beneath the rain cover, to effectively showcase the air circulation system and rain protection features in a scaled down version. The entry system in the mock-up is a simplified representation and does not provide a detailed depiction of the overlapping design or the loop-and-toggle mechanism.

5.1.2 Purpose of the mock-up

Despite its compact scale, the mock-up effectively highlights the design intent and functionality of the $\text{My}_{\text{celium}}$Tent, serving as both a visual and structural reference for its real-world counterpart.

5.1.3 Material selection and design

The final product will be constructed using mycelium, which is why a sample of the material is exhibited alongside the mock-up (Figure 5). The mock-up was constructed using simple yet functional materials. Cotton textiles were utilized for the rain cover and main body, welding wire served as the structural framing, and mesh material was employed for the mosquito net. These materials were deliberately selected to effectively demonstrate the design and functionality of the product in the simplest possible way.

5.1.4 Mock-up pictures

Figure 4: Final mock-up

Figure 5: Sample of compact mycelium

6 Testing

This chapter examines the testing phase, which is critical to ensure that the product meets technical specifications and fulfils customer requirements. The expected results are then evaluated and further discussed in subsection 6.2.

6.1 Tests

The testing process is divided into two principal areas: Verification and Validation. Each are has three different tests listed. For every test the requirement, test procedure and the expected result is described.

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 other side, 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) o 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, 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% by 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 MBL 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 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 themself dry and clean. ⇒**Fulfilled**

The use of the fully developed mycelium-based material is crucial for the tests outlined in this subchapter. Since a mock-up does not accurately represent the material's properties and behaviour in its final form, these tests must instead be conducted 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 (Figure 5), demonstrate that it is feasible to produce a mycelium-based material with similar properties. Nevertheless, 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 fact 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 $\text{My}_{\text{celium}}$Tent project has sought to address 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 to 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 prioritise 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.

8 Appendix

8.1 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/

8.2 Lists and references

List of Tables

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9 Attachments

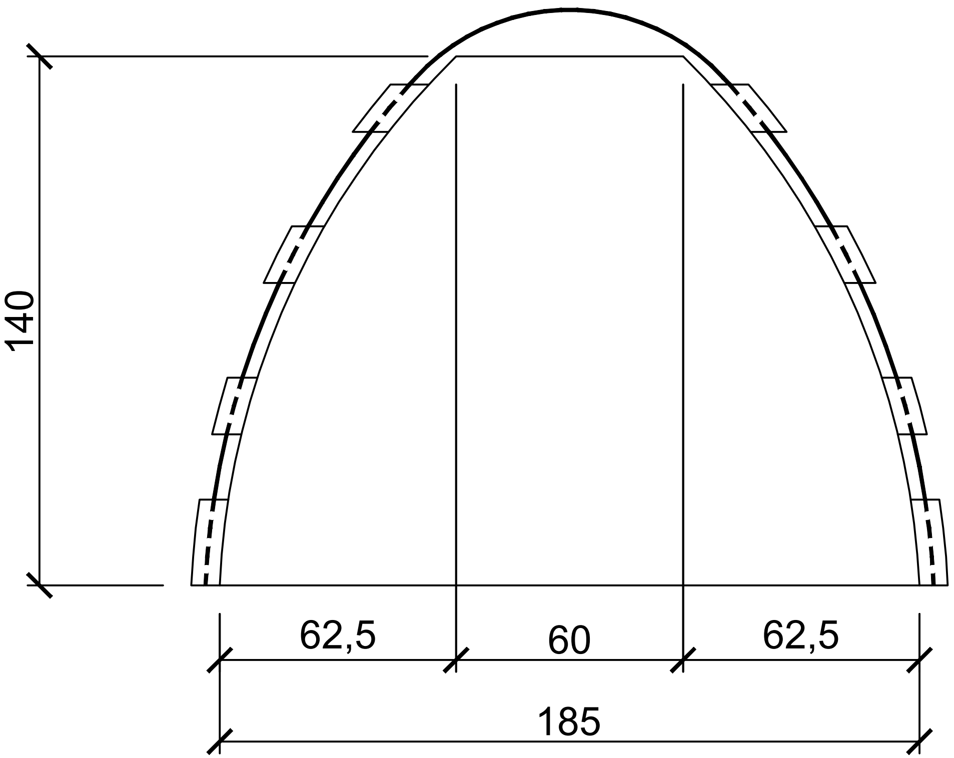
Table 7: Appendix: Initial morphological box

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	

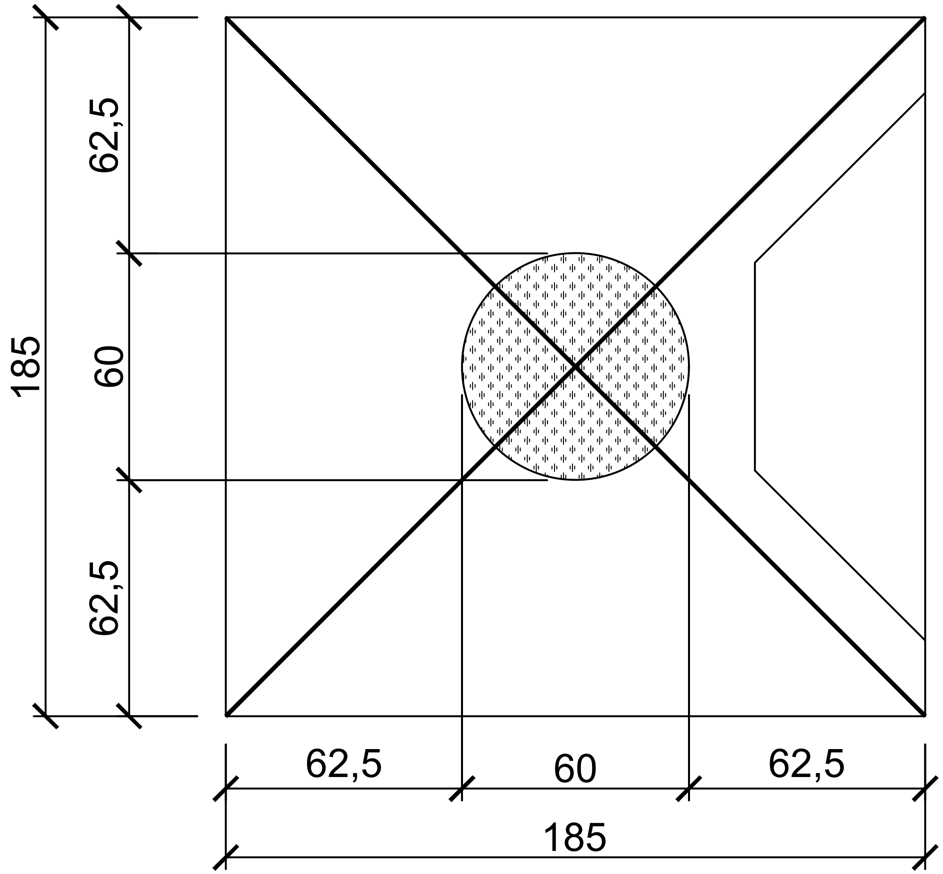
Table 8: Appendix: Slimmed-down morphological box

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~~	

SIDE VIEW

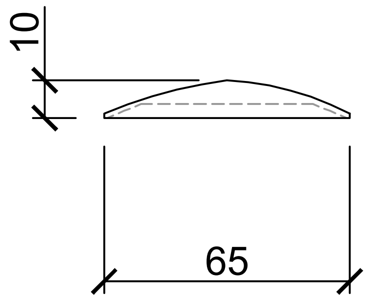


TOP VIEW



REMOVABLE CAP VIEWS

SIDE VIEW



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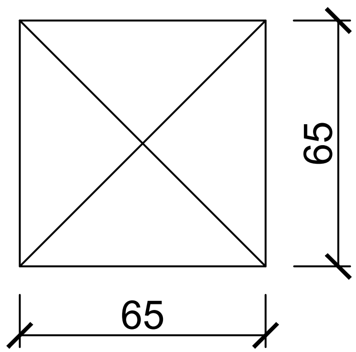

drawing in cm

MY$_{celium}$TENT SIZES		**HSLU Hochschule Luzern**	
Team:	31	Version:	v3 - tent and cap sizes
Author:	Matteo Frongillo	Scale:	1:20
Istitute:	HSLU	Page size:	A4
Module:	Context 1	Date:	08.12.2024

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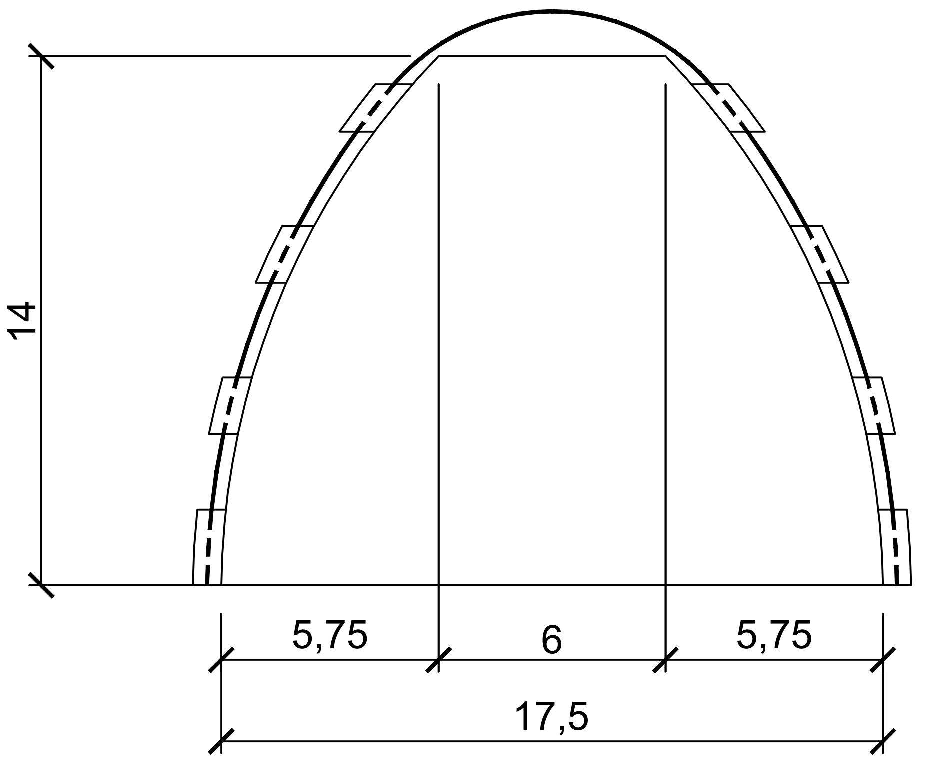

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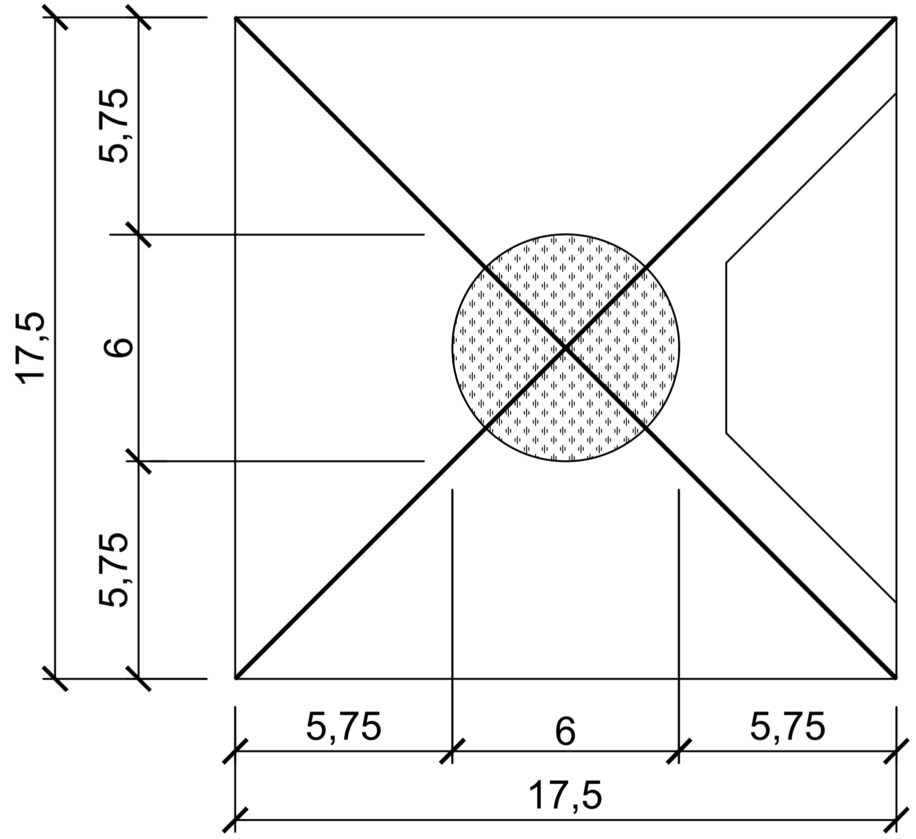

REMOVABLE CAP VIEWS

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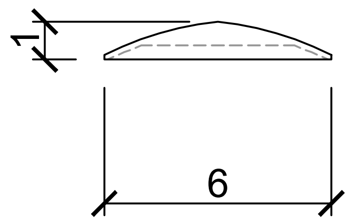

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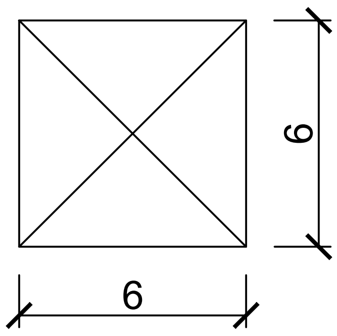

drawing in cm

MY$_{celium}$TENT MOCKUP		HSLU Hochschule Luzern	
Team:	31	Version:	v3 - mock-up sizes
Author:	Matteo Frongillo	Scale:	1:2
Istitute:	HSLU	Page size:	A4
Module:	Context 1	Date:	06.12.2024