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STANIŠĆE

Recycling Center

ABSTRACT

The proposed research and production center is located on the island Hvar in Croatia and is situated on the local Stanisce landfill. The purpose of this architectural project is to provide research and production facilities, laboratories, and educational spaces with the long-term aim to eliminate the local landfill waste.

THESIS STATEMENT

My goal is to present a novel and innovative solution to the global problem of growing landfills. The solution is to use landfills as a resource to create new building materials. The design of my architectural project will showcase the unique possibilities of these new materials. The Stanisce Recycling center will be an innovative case study for how to turn landfill waste into valuable and unique building materials and the project itself will be built using recycled waste materials.

The Stanisce Recycling center of recycled waste materials is the missing link needed to transition from a tourism dependent island, to a self-sustaining economy. This transition will turn the negative effects of the tourism industry into positive long term economic growth.

The project will also function as a knowledge hub to educate and involve the local community and visitors in the recycling process. The aim of the Stanisce Recycling center is to prove that the recycling of landfill waste into building materials is possible, sustainable and preferable compared to current landfill management solutions.

As the island of Hvar is a small and contained location, it is the perfect site to demonstrate the viability of this concept so that it can be replicated and used on a larger scale globally.

TABLE OF CONTENTS

FRAMEWORK

01

The framework contains background information on what landfills are, their use and negative effects. It presents the chosen topic of recycling waste materials from landfills including the three main categories of waste (plastic, organic and paper) and how they can be transformed into building material.

WHAT IS A LANDFILL?

A landfill, also known as dump, rubbish dump, garbage dump, or dumping ground, is a site for the disposal of waste materials. Landfill is the oldest and most common form of waste disposal.

Some landfills are a hole in the ground filled with waste whereas others are pilled waste placed directly onto the ground.

Landfill sites contain both household and commercial rubbish. Household waste that gets sent to landfill consists of organic waste, for example food, paper, cardboard or wood and plastic or tin packaging.

According to the EU's waste hierarchySearch for available translations of the preceding link•••, landfilling is the least preferable option and should be limited to the necessary minimum.

In 2018, 24% of all municipal waste generated in the EU was landfilled. This can have dangerous effects on human health and on the environment. The generation of leachate can contaminate groundwater and methane is produced, which is a potent greenhouse gas. In addition, where recyclable waste is landfilled, materials are unnecessarily lost from Europe's economy. (Europian Comission, 2021)

Types of landfills

There are 3 main categories of landfills: Municipal Solid Waste Landfills (MSWLFs), Industrial Waste Landfills, and Hazardous Waste landfills.

MSWLFs were created to dispose of household waste and other types of nonhazardous waste. Bioreactor landfills are a subcategory of MSWLFs. These landfills rapidly transform and degrade organic waste.

Industrial Waste Landfills collect commercial and institutional waste. Even in smaller cities or suburbs, commercial and institutional waste make up a large portion of solid waste and must be disposed of. Subcategories of industrial waste landfills include:

- Construction and Demolition (C&D) Debris Landfills, which are designed to collect construction and demolition materials. These include debris from the construction, renovation and demolition of buildings, roads and bridges, etc.

- Coal Combustion Residual (CCR) landfills, which are used to manage and dispose of coal combustion residuals.

- Hazardous Waste Landfills specialize in hazardous waste disposal. The exact opposite of MSWLFs, these landfills do not collect solid waste; rather, they focus on materials that may be dangerous or destructive. Related to hazardous waste landfills are polychlorinated biphenyl (PCB) landfills, which exclusively work with PCB and related materials.

NEGATIVE EFFECTS OF LANDFILLS

Solid waste is the main contributor to the creation of landfills worldwide. Because most of the waste products are not biodegradable, they lay in landfills for years. The result is worse in poorly managed landfills, as the waste damages the land and the environment.

Landfills are potential sources of pollution in the environment that can cause water pollution, air pollution, soil pollution, and pollution of the natural environment. It can contaminate surface water , groundwater resources and cause air pollution by emitting dust and gases. There is always the high risk for fires due to the production of flammable gases in landfills because of the activity of microorganisms in landfills. Landfills emit over ten toxic gases, with methane being the most fatal.

Methane is naturally produced in activities involving organic matter decay from different sources. The methane released from unmanaged decomposing organic matter in landfills can also trap solar radiation 20 times better than carbon dioxide. That results in increased global temperatures, especially in urban areas where most landfills are located(EPA, 2021).
Besides methane, other agricultural and household chemicals like bleach find their way in landfills and generate toxic gases that highly affect the neighborhood's air quality.

Landfill sites can impact the biodiversity in many ways, such as:

- The creation of landfill sites requires wild areas to be cleared, leading to habitat loss and degradation.

- As landfill sites are filled, some local species can be replaced by other animals that feed on refuse, like rats and crows.

- Leachate is the liquid produced in landfill sites. This can become toxic and thus contaminate nearby streams, ponds and lakes, damaging the habitat of many different organisms.

- Soil fertility is impacted too. The combination of toxic substances and decaying organic material can be of detriment to the soil quality, distorting soil fertility and activity, affecting plant life.

RECYCLING LANDFILL WASTE

Landfills are used to dispose of a variety of waste. Using land to store the waste creates a lot of problems for the environment. They are major sources of CO2 emissions caused by the waste breaking down. An example is the organic waste breaking down and releasing methane into the air when it decomposes. It creates a greenhouse effect which is one of the biggest threats coming from landfills. According to UNISAN 2020, 'when organic material such as food scraps and green waste is placed in landfills, it is generally compacted down and covered. This removes the oxygen and causes it to break down in an anaerobic process. Landfill gas comprises 35-55% methane and 30-44% carbon dioxide. Methane is also a flammable gas that can become dangerous if allowed to build up in concentration. Both of these gases contribute to global warming'. Landfills are also damaging local ecosystems by releasing toxins that pollute large amounts of groundwater and soil. The creation of landfills typically means destroying natural wildlife habitats and impacting the flora and fauna around the landfills. Emissions from landfills pose a threat to the health of those who live and work in close proximity to them. They bring hazards such as smoke, smell, insects and water supply contamination.

Today there is a lot of focus on how to recycle, reuse and repurpose construction waste into new building material. However, there is not enough focus on how to recycle landfill waste into usable building material.

5 tonnes of waste
is produced by the average European each year

Only 38%
of waste in the EU is recycled

Over 60%
of household waste still goes to a landfill in some EU countries

The process of recycling waste

The first step in the recycling process is to build a successsful sorting facility to sort existing as well as future incoming waste into the main waste categories. These categories include:

- Organic waste, plastic, paper/cardboard, glass, metal, wood, leather, hazardous waste etc.

Once the waste gets sorted into these different categories, it gets further refined into sub-categories. When all the raw waste has been sorted to its sub-categories the recycling process can start. The next step is to build a recycling or production facility that can transform the refined waste into a variety of materials, including building materials.

Once there is a working recycling system in place, it becomes more efficient and affordable to sort and recycle future incoming waste.

MYCELIUM

Mycelium is a root-like structure of a fungus consisting of a mass of branching and threads. Fungal colonies composed of mycelium are found in and on soil and many other substrates. Mycelium is mainly composed of natural polymers as chitin, cellulose, proteins, etc, so it is a natural polymeric composite fibrous material.

Due to its unique structure and composition we foresee the production of large amounts of mycelium-based materials.

Unlike conventional materials, this material grows and therefore has a different development process. The material is produced by adding fungal mycelium to an organic substrate. When combined, the mycelium obtains the nutrients from the substrate to grow and through this process it binds all the loose particles together, creating a composite material. In tinkering with the material, I realised that the ultimate material qualities (technical and experiential) depends on material ingredients, the growing condition and final processes.

What sets mycelium apart from other materials is its ability to regenerate at a quick rate. It can even be used for 3-D printing and is non-toxic, insulating, and all-natural. Mycelium has the potential to create a new paradigm for design in the building industry.

Mycelium as a construction material
Mycelium are the thin root-like fibres from fungi which run underneath the ground. When dried it can be used as a super strong, water, mould and fire resistant building material that can be grown into specific forms, thus reducing the processing requirements. Mycelium composites have customisable material properties based on their composition and manufacturing process and can replace foams, timber and plastics for applications, such as insulation, door cores, panelling, flooring, cabinetry and other furnishings. The mycelium brick is not as strong as a conventional brick but it is much lighter. Whereas bricks have a compressive strength of at least 28 MPa, the mushroom bricks can only withstand 0.2 MPa. But they are 60 times as light as the conventional brick: 43 kg/m3 as opposed to 2,400 kg/m3(Bio Based Press, 2020). Mainly mycelium as a construction material is used in non-load-bearing structures as an insulator and in interior walls.
Mushroom materials are durable, naturally fire resistant and very versatile.

Material properties
The mycelium tissue can trap more heat than fiberglass insulation, it is fireproof, nontoxic, partly mold, water resistant and very light.

PLASTIC

Accumulation of plastic waste over the years and the lack of suitable disposal techniques have given rise to a crucial and unparalleled crisis where plastic waste is overflowing the landfills. Plastic materials never degrade completely but disintegrate into smaller pieces over hundreds of years.
According to a report by the United Nations Environment Programme, around 300 million tonnes of plastic waste is generated every year globally, whereas recycled plastic waste merely counts to 9%.

Plastics are strong, durable, waterproof, lightweight, easy to mould, and recyclable – all key properties for construction materials.

Advantages of using recycled plastic material
Cost
One of the main advantages to using plastic as a construction material is the cost to produce and use plastics – it is less expensive than most other materials. It is generally cheaper and can easily be produced in much larger quantities than metal. This is the main reason that plastic is commonly used in construction. The amount of energy it takes to manufacture plastics is far fewer than the amount it takes to produce metals.
Resistance
Plastics have a high resistance to corrosion, making them perfect for use where a metal may start to rust and corrode.

Weight
Plastic is a very lightweight material compared to many other construction materials, this gives the material a greater flexibility in its use on site and in transportation. Plastic can be transported in much larger amounts than other materials because of their weight, this cuts down on transportation costs to a construction site.
Colour
Plastics can easily be coloured in their manufacturing stage (especially if its combined with different colors or plastic waste) which is a useful property to have on a building site. Parts can be colour coded according to size or the use of the part, this would be much more difficult and time consuming with metal parts.
Environment
The process of manufacturing and the use of plastics on a construction site uses a lot less energy than metals, this is because plastics are so much lighter so the energy used in construction and transportation issignificantly lower.
Moulding
Plastics can moulded into intricate shapes in very large quantities, making them the perfect choice in construction.

Ways to recycle plastic
Plastic waste can be recycled either mechanically, chemically or thermally. However, before the plastic waste is recycled, it undergo sorting which is mostly done automatically using technology such as electrostatics, floatation, fluorescence, infrared and spectroscopy. The sustainable use of plastic waste for construction purposes also provides economic benefits.

Waste plastic bags, which are non-biodegradable, have been recycled for the production of floor and wall tiles with lesser flammability and enhanced tensile strength Environ. Prot., 124 2019, pp.: 299-307. It has been shown that plastic bags, which routinely contribute to soil and water pollution, can be developed into a lightweight and highly durable products.

PAPER

Paper is a valuable resource that is not optimally used. Large mounts of it are not recycled and end up on landfills. Yet it is a great building material. it's a material which could potentially be used for a number of different applications and is widely available around the globe. It can be used to make partition walls in ordinary homes or office buildings, as well as an alternative to MDF (medium-density fiberboard) in domestic applications, because the panels can be finished with varnishes and veneers in exactly the same way as MDF. One of the advantages of the material is that it's quick to manufacture and can be moulded into various shapes. So one manufacturer would potentially be able to create various different products from it using the same machinery, providing that machinery is adjustable.
Another key advantage over its competitors, such as thermoplastics, is its outstanding toughness.

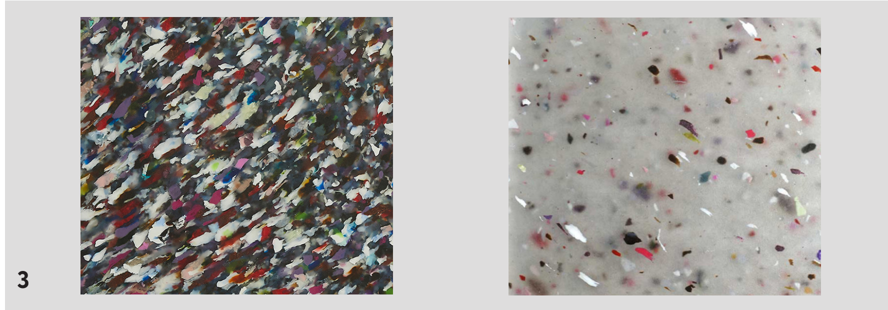
Why is paper a good building material?
It has numerous advantages in construction industry, namely low carbon footprint, recycled material usage, low embodied energy, high strength to weight ratio, high thermal insulation, high sound absorption, aesthetic and cost effective.

Materials made from cellulose fibres of waste paper
Construction board material can be made from a combination of enzymes and cellulose taken from the waste streams of paper production. (Honex,2020). Cellulose residue is taken from cardboard and paper waste generated at paper mills. This paper has already gone through several reuse cycles, meaning that the remaining cellulose fibres are too short to be bound together in order for it to be made into paper again. As a result, these fibres would typically end up in a landfill or be burnt – a process that creates an estimated seven million tons waste globally each year.
This material from being a waste can be turned into construction boards for interior partitioning or cladding.

MYCELIUM

Figure 1. Fungal growth
Figure 2. Mycelium bricks
Figure 3. Recycled plastic panels
Figure 4. Recycled paper panels

PLASTIC



PAPER

WHAT IS R&D?

Research and development (R&D) includs activities that companies undertake to innovate and introduce new products and services. It is often the first stage in the development process. (Investopedia, 2021)
The term R&D is widely linked to innovation both in the corporate and government world or the public and private sectors. The research and/or development is typically not performed with the expectation of immediate profit. Instead, it is expected to contribute to long-term profitability.

Models of Research and Development
One R&D model is a department staffed primarily by engineers who develop new products—a task that typically involves extensive research. There is no specific goal or application in mind with this model.

The second model involves a department composed of industrial scientists or researchers, all of whom are tasked with applied research in technical, scientific, or industrial fields. This model facilitates the development of future products or the improvement of current products and/or operating procedures.

There are also business incubators and accelerators, where corporations invest in startups and provide funding assistance and guidance to entrepreneurs in the hope that innovations will result in benefits for everyone.

Three types of R&D
Basic research - is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

Applied research - is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective.

Experimental development - is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

Why is R&D important?
R&D is important for businesses because it provides powerful knowledge and insights, leads to improvements to existing processes where efficiency can be increased and costs reduced. It also allows businesses to develop new products and services.

One of the main functions of my project is research and development of recycled building materials. Therefore it is important to understand what R&D is.

LOCATION

My project is located in Croatia. Specificaly on the island Hvar. The project encompasses a research, development and production center where main focus and research is recyclable waste from the landfill and the ways it can be transformed into building materials. The guiding idea is to transform something negative and wasteful into something positive and useful for the society.

TOWN HVAR

The town of Hvar is located on the south western side of the island of Hvar, which is included in the group of central Dalmatian islands of the Split-Dalmatia County.

The island itself is 72 km long with total length of the coast 254.2 km. with a population of 11 500 where 4 251 live in Town Hvar. It is the fourth biggest Croatian island by surface area. **Due to the large number of sunny days, it is also called Sunny Hvar.**

The composition of the City of Hvar includes the following 6 settlements: Brusje, Hvar, Milna, Malo Grablje, Velo Rake, Sveta Nedjelja and Zaraće. The landfil is located between the Hvar city center and settlement Brusje.

TRANSPORT

The island of Hvar is connected to the mainland by ferries via Stari Grad and Sucuraj and by catamaran to the town of Hvar.
On the island itself there are costal buses but the main transportation is by personal vehicles. It is very difficult to commute witout a car and if the village is close to the city some people tend to use bikes.

The only possible transport method to access the location of my site, landfill, is by car or a bike.

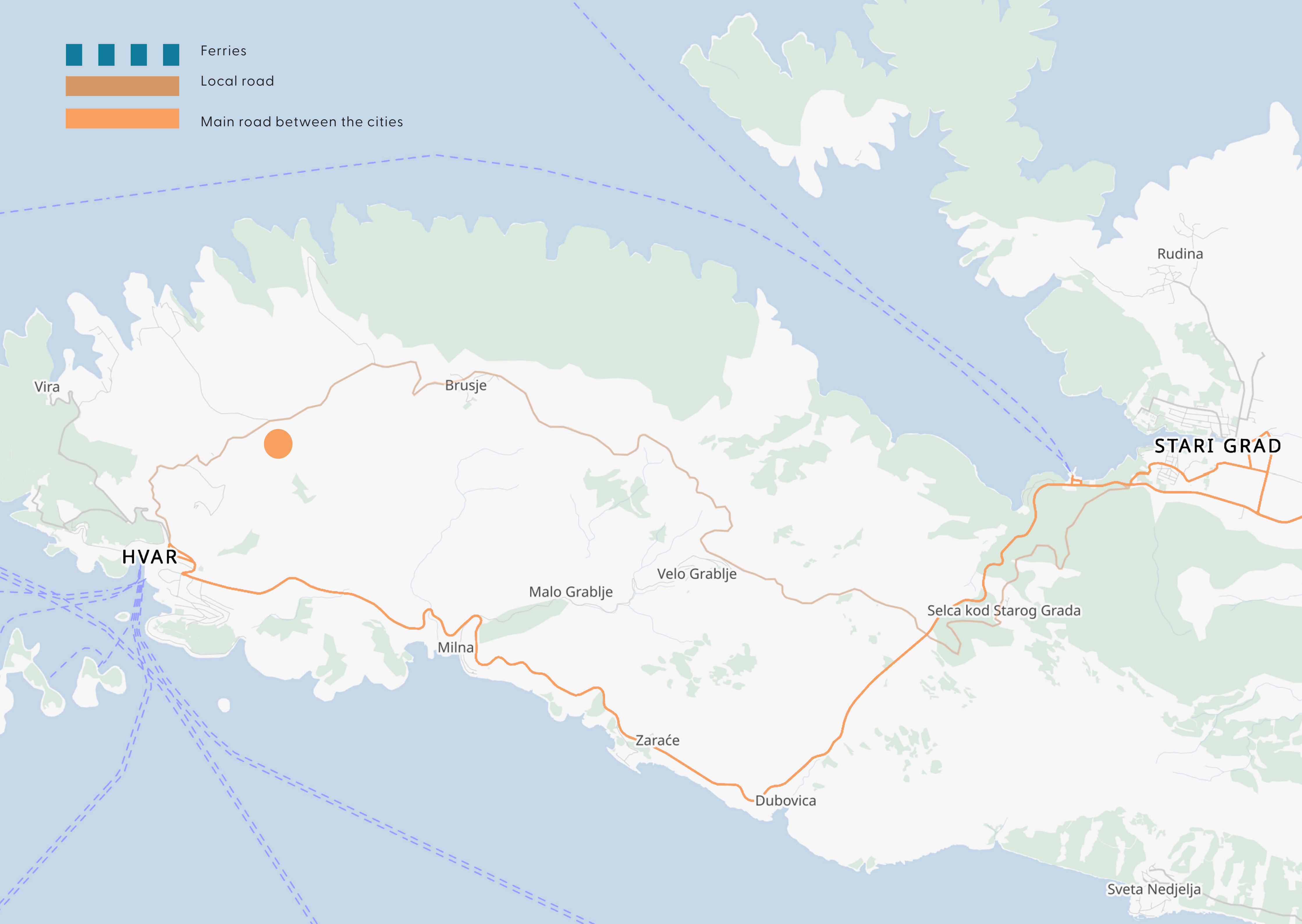
Ferries

Local road

Main road between the cities

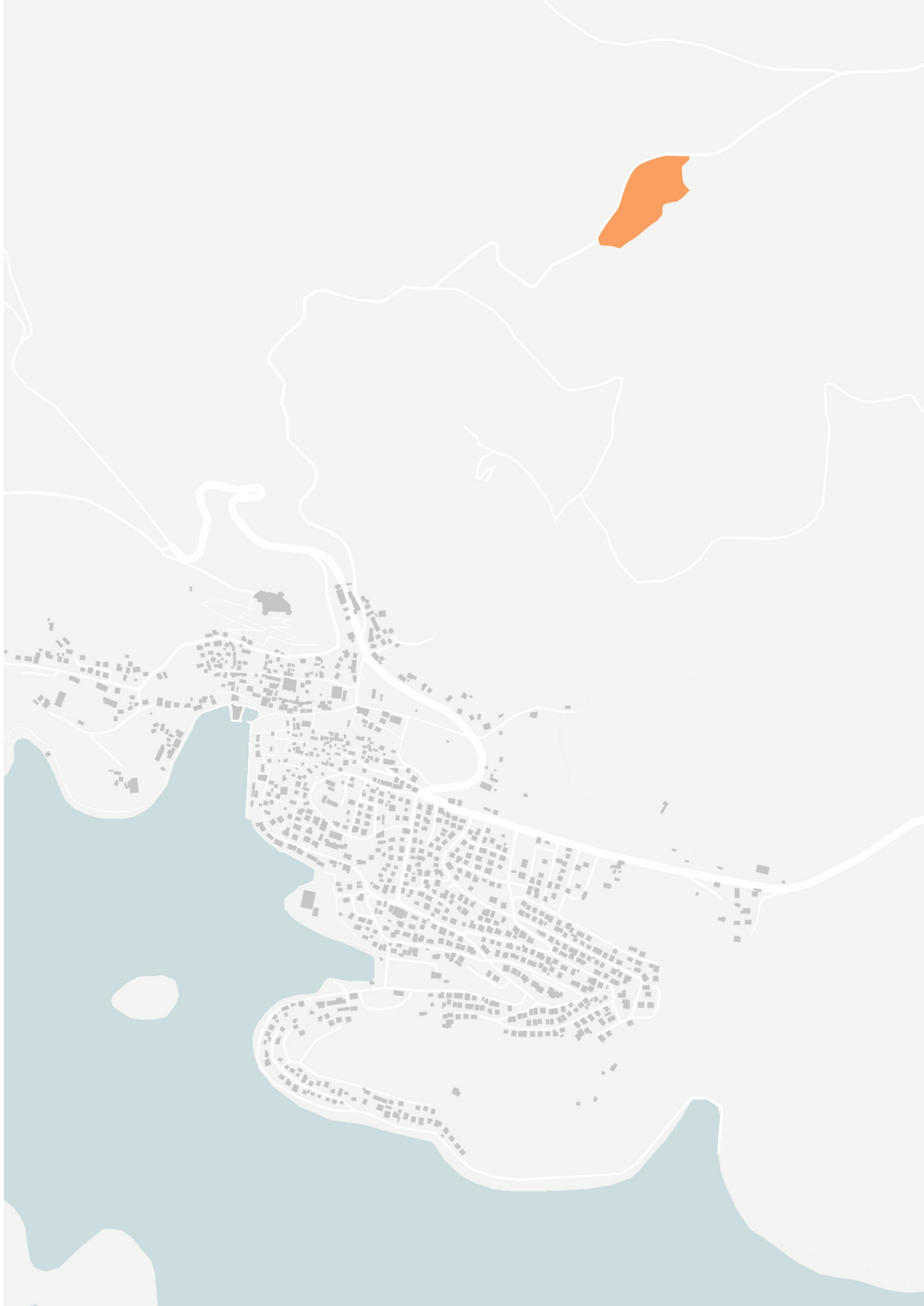
Tourists who arrive to Croatia from abroad and want to travel to Hvar, will first arrive in Split via airplane and take the catamaran to the city Hvar. In case they rent a car they can take a ferry going to Stari Grad and from there drive to Hvar which is 22km away.

The new road from Hvar to Stari Grad was constructed in 2019. Before the construction the only road to reach the city Hvar was the local road that goes trough the village Brusje. Today, most people traveling to the city Hvar by car, use the main road while locals and people living close to the city Hvar still use the local road.


Ferries
Local road
Main road between the cities
Vira
Brusje
Rudina
STARI GRAD
HVAR
Malo Grablje
Velo Grablje
Selca kod Starog Grada
Milna
Zaraće
Dubovica
Sveta Nedjelja

THE WIDER CONTEXT

The Stanisce landfill is located approximately 2.5 km north of the town of Hvar. The landfill is the primary method of dealing with waste produced by the inhabitants of the town as well as from tourists. The landfill is surrounded by natural habitat and is located between the town of Hvar and the connected village to the north, Brusje.



This chapter contains the important precedents for my project. The precedents is a collection of architectural projects that inspired the development and design of my project. They are importan in terms of the way these projects work with their location, the enviroment and spacial design.

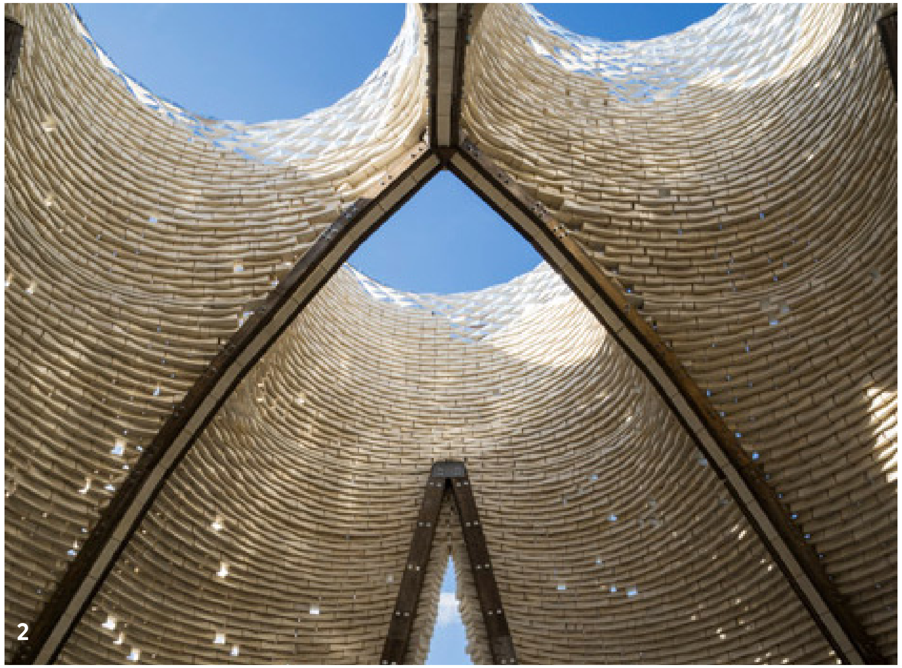
PRECEDENTS

02

HY-FI

The Hy-Fi project was designed by The Living architecture studio principal David Benjamin, in 2014. The Hy-Fi was the winning project in the annual Young Architects Program (YAP) contest, which each year invites emerging architects to propose a temporary structure that will host MoMA Ps1's summer events. The structure is built entirely from biodegradable materials. Each of the bricks used to construct it were grown rather than manufactured, using a combination of agricultural byproducts and mushroom mycelium – a kind of natural digestive glue. Specially designed moulds were used to cultivate the bio-bricks. These were coated in a light-refracting film developed by the materials firm 3M and some were then built into the structure around the top, helping to bounce light down inside. Gaps in the brickwork also help to naturally ventilate the interior using the stack effect, drawing cool air in at the bottom and pushing hot air out at the top.

This project is an important precedent because of its innovative use of unique mycelium building material based on agricultural byproducts. It showcases the possibilities of selfsupporting conal and dome structures using a light brick material. This structure also showcases the possibilities of versatile construction and parametric design of complex forms based on a simple brick. The building can easily be expanded or disassembled in the future and the material itself can be fully reused and recycled for several cycles. No waste is left behind.



RELEVANCE

My project uses the same method of construction in terms of creating complex parametric forms based on a group of simple, yet versatile building blocks. The construction can be efficiently assembled and disassembled and changes or expansions can easily be implemented. My project will similarly be presented as a showcase of the unique possibilities of these new materials.

Fig 1. Fungal growth bricks
Fig 2. Inside structure

ICEBERG LIVING STATION

The iceberg living station is a project designed by MAP Architects in 2010. It's a conceptual project located in Antarctica and is a living station for 100 visitors with minimum environmental impact. The aim is to avoid building by traditional means, which would implicate transporting materials foreign to the continent which would never leave Antarctica again. Instead, the architecture is holed out in a super large iceberg which would eventually melt in 7 to 10 years time. Icebergs are compacted snow, which only become ice at a depth of 25 metres, and as igloos have demonstrated trough out the centuries, snow provides very efficient insulation. Caterpillar excavators, traditionally used in the Antarctic to move and clear snow, would cut out the spaces inside the iceberg. The geometric logic of the movement of these machines, now used to design and cut the spaces, create the curves of the interiors.

This project is an important precedent for my project in terms of it's location in a hostile envrionment, it's focus on locally sourced building material, and the minimum impact on the local environment. The design is tailored to existing machinery and local material sources that are shaping and leading the design.


1


2

RELEVANCE

My project will similarly transform local landfill waste into a unique building to construct unique architecture with minimal impact on the local environment. It will not just use the waste for material production, but the architecture will be formed by local waste. My project will support the same versatility, meaning that it can be expanded or changed over time, depending on the needs of the user and the city. The architecture is unique, because it is based on the specific properties of the recycled waste materials. Stanisce R&D center is also carving itslef out of the existing landfill and gradually transforming it.

Fig 1. Fungal growth bricks
Fig 2. Inside structure

EUROPEAN CENTER FOR GEOLOGICAL EDUCATION

The european center for geological education was designed by WXCA Architects and is located in Checiny, Poland and was finished in 2015. The project is a science center for geological research. The complex is comprised of five buildings. The first main building includes and entrance lobby and auditorium hall. The second building is a research laboratory facility with geological laboratories. The other three buildings are inteded as a hotel base functioning as accomodation for researchers, workers, students and visitors. The project is located in an old, exploited quarry. The rectangular blocks of the buildings are scattered around the quarry as rocks to to resemble the former function of this place. The shape of the buildings create a connection between what is natural and what is processed. The intention of the project was to create forms that will not dominate, but compliment its unique location. Each main program is located in separate building with a fluid circulation connecting them.

This project is an important precedent for my project in the way that it deals with its location, its use of materials closesly connected to the site and its function. Lastly the connection between visually separated programs with a fluid connection. The design of the project as well as the construction materials used all reflect the function of the building and the history of the surrounding site.

RELEVANCE

My project will similarly have a close connection between its design, the material used in its construction and the surrounding location. This project showcases the deep history of the site while displaying a new structure, while my project will be located within the raw source for the materials used in the construction of the building. The building will reflect the transformation from the waste it is located in.

Fig 1. Outside buidling facade
Fig 2. Inside stone incorporation

NEW URBAN CAMPUS OF BOCCONI UNIVERSITY

The new urban campus of Bocconi University was designed by SANAA Architects and is located in Milano, Italy. The project was finished in 2019. The project comprises several buildings, each with its own program: the teach and administration building, dormitories and recreation center. The buildings are open to the university and general public. The volumes that compose the teach and administration building touch one another lghtly, allowing for a flow of students and professors from one cell to the next. Each volume has an interior courtyard and is designed to have its own distinct character while being part of a larger system. Once inside, the architecture is permeable throughout and characterized by a sequence of columns, transparent rooms and trees.

This project is an important precedent because of the use of ciruclar spaces and in how they intersect and connect. It presents solutions to how the interior circular spaces and circulation in my own project can be solved. Lastly it shows how each function or program is designed uniquely while still being a part of a unified larger scale system.

RELEVANCE

My project is a cluster of conal structures that intersect and create unique circular interior spaces. This SANAA project works with a circular layout and fluid connectivity between a variety of programs. Circular layouts present a variety of unique challenges and possibilities, and this project was an important precedent to describe how such layouts can be solved.

Fig 1. Outside buidling facade
Fig 2. Ground floor plan

ARMADILLO VAULT

The Armadillo vault was designed by team led by ETH Zurich researchers, engineering firm Ochsendorf DeJong & Block and masonry specialist The Escobedo Group. It is located in Venice, Italy. The project was the centrepiece of the Beyond Bending exhibition at the Venice Biennale for Venice Architecture Biennale 2016. Armadillo Vault is a pioneering stone structure that supports itself without any glue. The curving canopy features structural spans of up to 16 metres, but is supported entirely through compression rather than with the use of adhesives or fixings. The project was developed using Rhino VAULT, a digital design plugin that is licensed by ETH Zurich and has over 16,000 users. It is intended to demonstrate that, with detailed knowledge of how compressive forces affect architectural structures, buildings can be constructed more efficiently using sustainable materials rather than steel.

This project is an important precedent because of the innovative use of stone material in a self-supporting vaulted structure without the use of glue, bolts or mechanical connections. Instead it is parametrically designed to use the compression forces with specifically fabricated shapes of stone to create the vaulted structure.

RELEVANCE

This project is significant because of its innovative configuration of an existing conventional material. It presents the possibility of creating such a complex structure without the use of glue or other adhesives, which is the case in Stanisce Recycling center, where recycled plastic material isconfigured in complex conal forms without the use of glue or mortar.

Fig 1. Armadillo vault
Fig 2. Detail construction

The site analysis contains all significant information of the site and its surrounding, including history, urban development, economy and landfill management.

SITE ANALYSIS

03

HISTORY

The island of Hvar has been inhabited since prehistoric times. Archaeologists have found traces of life on the island of Hvar dating back to 3500 BC. Kr. After the Second World War, Hvar, like the whole of Croatia, was part of socialist Yugoslavia. In that period, from 1945 to 1991, several hotels were built in Hvar, water supply and sewerage were built, and the town prospered in every way. During the Homeland War from 1991 to 1995, Hvar was not damaged by enemy shells, but with the accommodation of refugees from the occupied territories it endured a heavy burden that is still felt today.

Due to the tourism Hvar has become one of the leading tourist destinations in Croatia. The relief features of the island of Hvar derive from the position of the island as part of a unique tectonic unit of the central Dalmatian islands that fall within the outer Dinarides. The Croatian coast and islands lie in the area of the Adriatic type of Mediterranean climate and dry and hot summers, wet and mild winters.

Hvar has been welcoming visitors for millennia. On the sailing route of both trade and pilgrimages, Hvar has always been a strategic point of interest, from modern sailing tourists to previous invading armies.

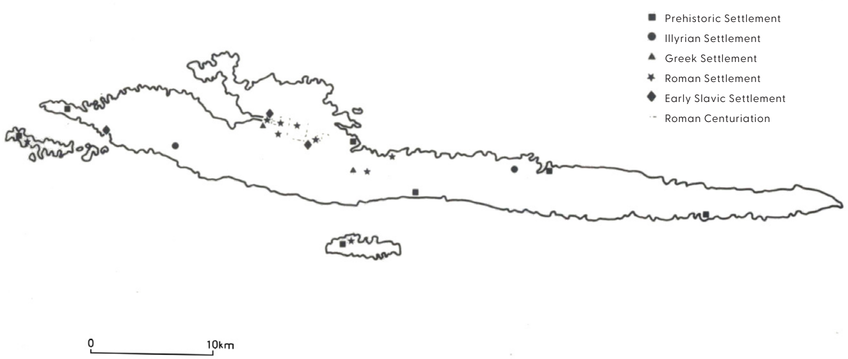
1

Hvar, the cradle of Croatian tourism, celebrated 150th anniversary of tourism.

Fig. 1 History of Hvar

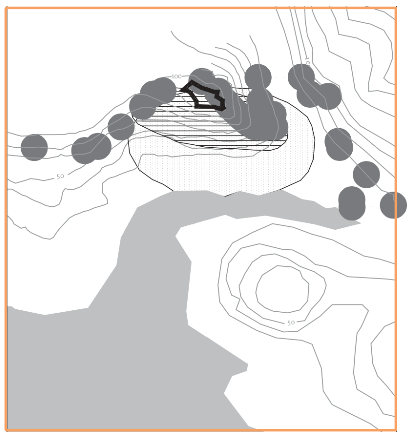
The island is rich in archaeological and historical remains dating from the Neolithic onwards and there is evidence that some of the village sites have been inhabited since prehistoric times. Human settlement on Hvar has been increasingly investigated during recent decades ranging from finds of Neolithic painted pottery, Bronze and Iron Age burials and tumuli, Greek and Roman colonization through to an appreciation of archival and architectural remains from the Venetian period, and the more practical results from the Austrian and French occupations of the island in the nineteenth century.

Archeological and historical remains on Hvar Island

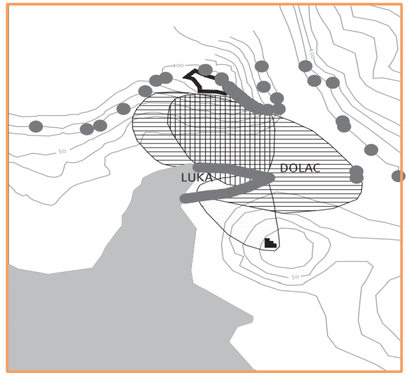


URBAN DEVELOPMENT

These maps show the urban development of the town of Hvar from the beginning of the Greek presence, to the Roman times and early middle ages until the 16th century, 19th century and lastly the 21st century.



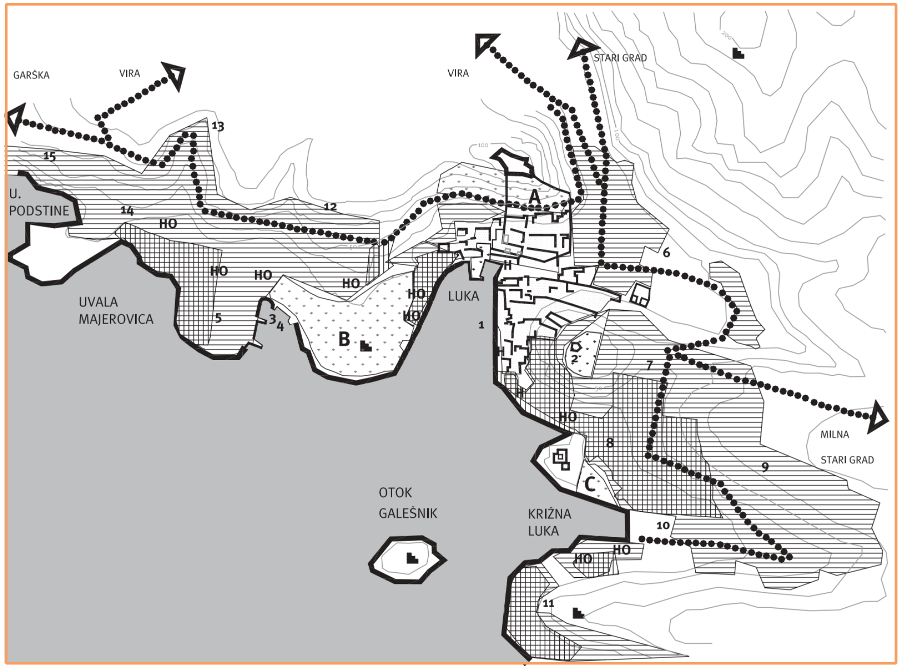
Hvar settlement from the beginning to the Greek presence



Hvar settlement from Roman times to the early Middle Ages

Hvar in the period from the 16th century to the middle of the 19th century

Hvar in the period from the 19th century to the 21st century



Maps source: Urban Development of Hvar, Review of Main Stages

ECONOMY

The town of Hvar is a large mid-Dalmatian island covering an area of 110km. According to the 2011 census there were 4,251 inhabitants in the town of Hvar compared to 4,143 in 1991 and 4,138 in 2001. There was a slight 2.6% rise in the number of people living in the town from 1991 to 2011 and 2.7% from 2001 to 2011. In the period between 1945 and 1990 Hvar turned from a small provincial town into a fashionable summer resort attracting large numbers of visitors and opening its doors to mass tourism.

Ever since 2000 mass tourism has been growing steadily regardless of the ecological and socio-cultural capacity of the town. Between 2010 and 2017 the number of overnight stays increased by 62% in Hvar Town in comparison with 40% on Hvar Island and 53% in Croatia. Such rapid growth of tourism is harmful to the existing ecological, social and economic resources of the town as well as damaging to the image of Hvar as a cultural and historical destination. **This type of tourism puts a lot of strain on the environment, identity and infrastructure management of the whole island.**

The population structure of Hvar Town (employment by economic sector, Table) shows the town's strong reliance on tourism. Almost 36% of people work in tourism, which is a very high percentage compared to Split-Dalmatia County (8%)or the whole of Croatia (6%).

Population structure in the town of Hvar
(employment by economic sector)

Area	Total number of inhabitants	Employed persons (%)	Agriculture, fishing and forestry (%)	Industry, construction, mining, energy and water management (%)	Trade, traffic and other services (except tourism) (%)	Tourism (%)	Healthcare, education culture and public administration (%)
Hvar Town	4,138	40.5	8.4	8.0	31.0	**35.6**	17.0
Hvar Island	11,103	36.9	15.8	13.1	29.7	**24.7**	16.7
Split-Dalmatia County	463,676	32.2	2.2	24.1	41.1	**8.1**	24.4
Croatia	4,437,460	33.9	5.3	27.7	37.2	**6.1**	23.8

Source: Hvar Tourism development strategy for the town of Hvar 203

STANIŠĆE LANDFILL

The Stanišće landfill began to be used in 1959, and was built on a rocky outcrop, which was covered with low vegetation and maquis before the start of disposal. Today it is with an area of 2,429 hectares land. At this landfill waste has been disposed of in an unsanitary manner since 1959. By 2019, a total of 3,382.46 tons of waste was disposed of in this landfill, of which 2,198.60 tons is the amount of biodegradable utility component. Of the total amount of disposed waste, 60% is municipal and 40% is construction waste.

Environmental Impact

Stanisce landfill is used to dispose of a variety of waste. Not only does the landfill create problems for the environment, but also for the local inhabitants and wildlife. This is a major source of CO_2 emissions caused by the waste breaking down. Another issue with the landfill is the smell that is being relesed by the waste and during the time when there is a lot of wind it even reaches the city center.

Type of waste

Until 2008 there was 170 000m3 of waste that is equal to 119 000 tones Yearly the town Hvar produces around 3500 tons of waste that is being added to already existing amount and today there is 100 000 m3 of waste which is equal to 70 000 tons. There has been a slight decrease of waste due to the fact that it has been burned or transported out of the island. This is an unsustainable process of dealing with waste and the landfill.

TYPE OF WASTE	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year 2008
Organic Waste	39,3	39	39	41	44	51,2	64	71	53	42	39	40	34% 561,9
Paper - cardboard	19,6	19	20	21	23	28,8	39	44	30	22	19	20	19% 305,3
Plastic	12,2	12	12	14	17	23,2	35	41	25	15	12	12	14% 229,5
Textile	7,8	7,8	7,8	7,9	8,2	8,8	9,9	10	8,9	8	7,8	7,8	101,1
Glass	6,9	6,7	6,9	8	9,7	13,7	21	25	15	8,6	6,7	7,1	134,4
Metal	3,9	3,8	3,9	4,2	4,7	5,8	7,8	8,9	6	4,3	3,8	3,9	61
Leather	2,9	2,9	2,9	2,9	3	3	3,1	3,1	3	2,9	2,9	2,9	35,5
Internal Waste	2,1	2,1	2,1	2,1	2,1	2,1	2,2	2,2	2,2	2,1	2,1	2,1	25,5
Wood	1,2	1,1	1,2	1,2	1,3	1,6	2,1	2,3	1,7	1,3	1,1	1,2	17,3
Tire	0,5	0,5	0,5	0,5	0,5	0,6	0,7	0,8	0,6	0,5	0,5	0,5	6,7
Hazardous Waste	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	2,4
Rest	1	0,2	1	4,3	9,5	21,6	43	55	24	6	0,3	1,4	168,1
TOTAL	97,6	95	98	108	124	161	227	264	169	113	95	99	1648,7

Source: HUDEC, Stanisce landfill development

Future estimates

Report from 2020 presenting estimates for future additions to the landfill where the unsustanable hrowth of the landfill is clearly visible.

YEARS	Estimation of municipal waste for The town of Hvar	Estimation of quantities municipal waste for Stari Grad	Cumulative amount of added waste
2021.	3.500	1.700	5.200
2022.	3.500	1.700	11.400
2023.	3.500	1.700	16.600
2024.	3.500	1.700	21.800
2025.	3.500	1.700	27.000

Key Metrics

Built: 1959

Size: 2500 m2

Amount of Waste 2021: 70 000 tons

Amount of Waste 2025: 100 000 tons

Main Waste Categories: Organic, Paper, Plastic

SITE PICTURES

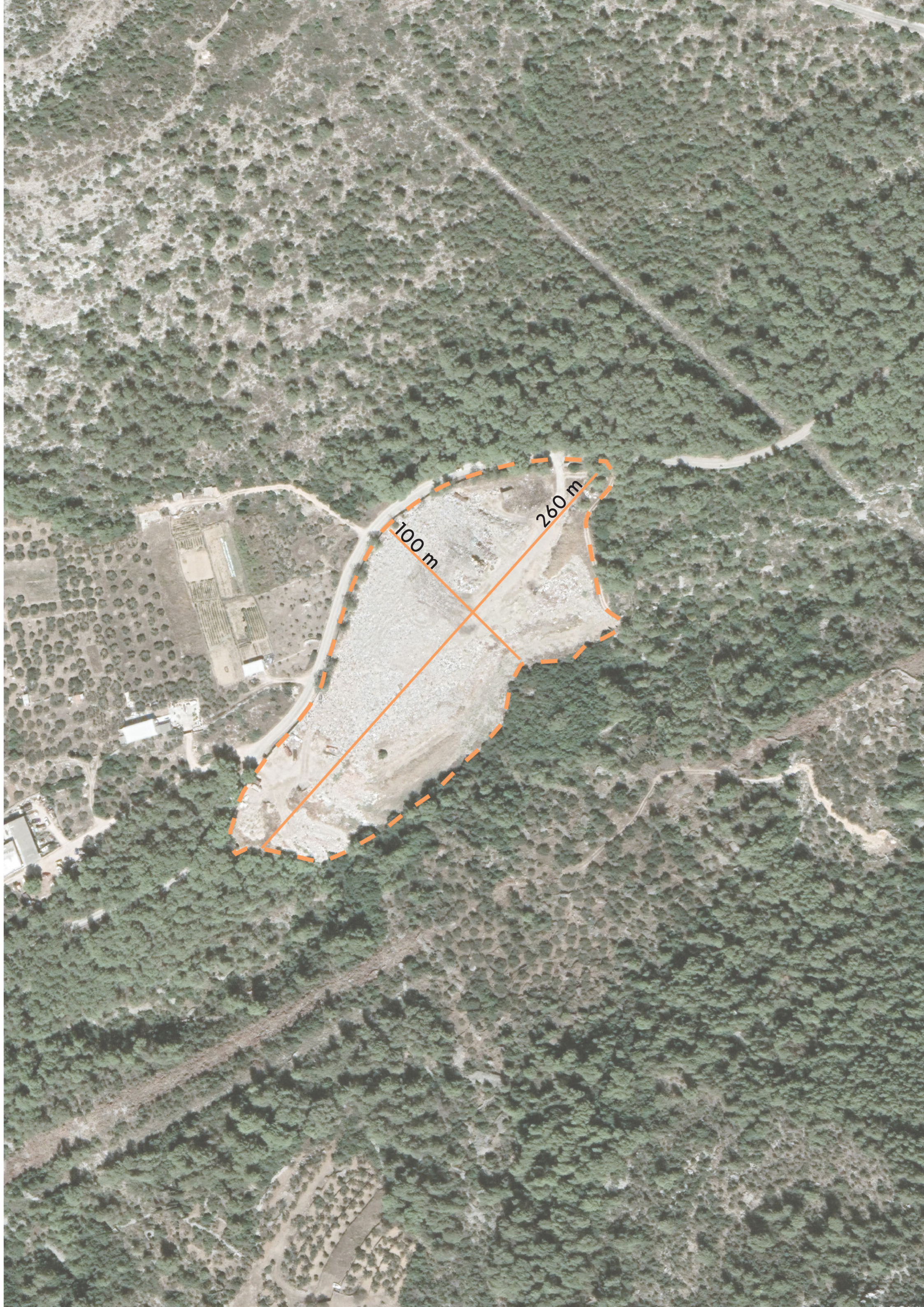
SWOT ANALYSIS

STRENGTHS
Abundance of valuable raw materials in the form of waste
Beautiful location surrounded by nature
Small scale landfill
No existing buildings or infrastructure

OPPORTUNITIES
Cooperation with universities
Strengthen the economy of Hvar
Make Hvar more economically independent
Rehabilitate natural habitat
Showcase unique architecture and innovative materials
Proof of concept

WEAKNESSES
Smell
Accessibility
Destruction of natural habitat, fauna and flora
Negative impact on groundwater and soil
Visual disturbance for commuters

THREATS
Insufficient funding
Bad management
Growing waste stream
Further destruction of natural habitat, groundwater and soil



This chapter contains the objectives that were important in the development of the project. These objectives include design principles and program requirements.

OBJECTIVES

04

DESIGN PRINCIPLES

For the design of my project I am following these design principles.

Waste reduction
Solid waste separation by creating a specific disposal area.
Recycling the waste on the site and turining it into building materials.

Protecting the ecosystem
Education and training for enviromental awareness. Research the current impact of the landfill as well as the impact over time.

Fluid circulation
Creating a comfortable and continous connection between all the programs and internal spaces. A fluid circulation throughout the project allows for a better visitor experience as well as connected spaces for researchers and workers.

Assembly/Disassambly
The project will utilize a versatile construction system so that structures can easily be expanded or altered after the initial construction.

Catalyst project
Showcase project/study showing the possibilities of the landfill waste being recycled and turned into construction materials for unique buildings. Not only for structure but also for furniture and a variety of internal design elements.

Sustainability
This project will support the transition from unsustainable landfill managmenet to sustainable landfill managment.

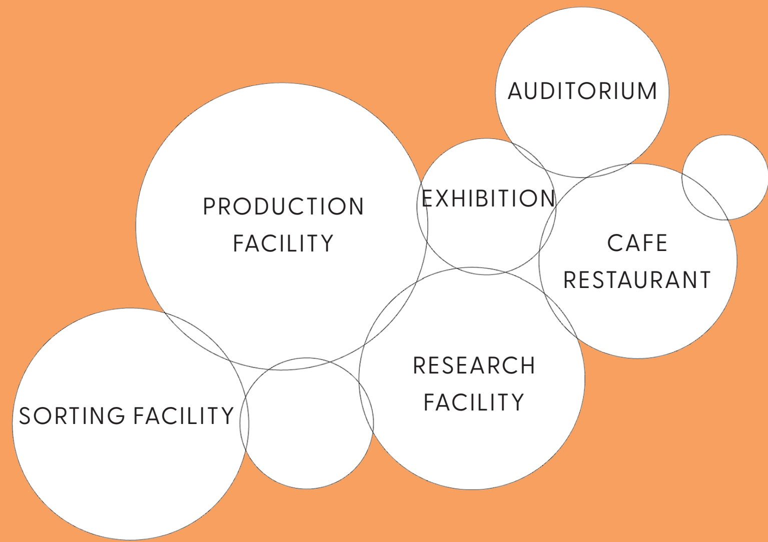
Circular Economy
My project supports the concept of circular economy by transforming local waste into valuable building materials that will be used in building projects on the island or outside the island as a renewed second cycle material. The materials will be designed and produced in such a way that they can be continiously recycled for many more cycles in the future.

Local production
The project will support and contribute to the local economy by producing unique building materials and other products locally.

PROGRAM REQUIREMENTS

The Stanisce Recycling Center requires several programs. First is a sorting facility that will be used to sort all the waste coming to the landfill. The size of the sorting facility is 600m2. This program is closely working with the pilot plant where those materials are being transformed from the waste into the materials ready for construction or other use. The area of the pilot plant is 900m 2. The next program is the research facility which includes laboratory and offices with an area of 530m2. The center also include an exhibition area for exhibiting materials and for organizing workshops with visitors. Located next to it is the auditorum for educational purposes and lastly the cafe with the main entrance lobby to the facility.

The production facility is split into three zones. Each of these zones will produce one main material category. These material categories are paper/cardboard, plastic and mycelium. The size of the production facility is a result of the spesific space requirements of the machinery needed for the production of the three material categories.



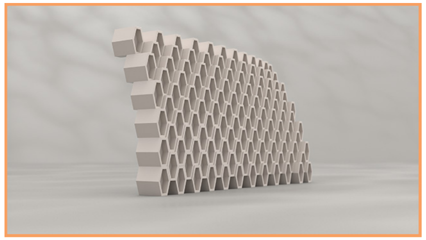
This chapter contains the concept development process. It includes a form finding study, the final concept, stages of construction, organization of programs and the construction system.

DESIGN DEVELOPMENT

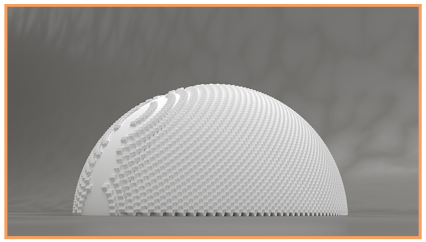
05

FORM FINDING

An important process during the initial stages of the design development was to conduct through form finding. The project and its design is novel in a variety of ways and the general form of the structure needs to reflect this. The form has to be efficient, cost-effective and constructed from new and unique materials that are recycled from the landfill waste. Early on, circular forms showed to be the most efficient to create large spans without the use of conventional building materials.

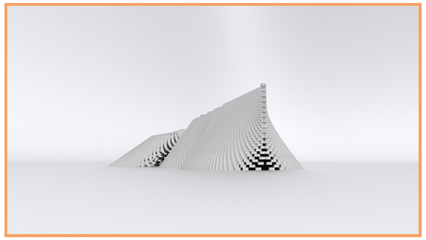


From the start, the main goal was to only use recycled waste materials for the entire structure. The most efficient way of achieving this is using a construction system consisting of one brick form that can be multiplied. This is an early experimentation with stacked hexagonal bricks.



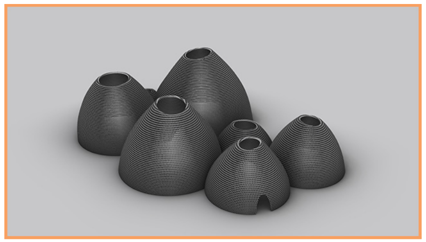
One of the first forms was a perfect dome constructed of identical hexagonal frames stacked on top of each other, oriented in the same direction. This form posed some problems with gaps and horizontal spans that were too long. The dome didn't function structurally or visusually.

With this example the form inverts and creates a funnel in the center. It uses square bricks stacked on top of each other. The problems are the intersections at the top as well as gaps towards the middle of the dome.



This iteration is a combination of the first form placed linearly with a contínous roof ridge connecting all the domes. Because all the bricks are oriented in the same direction it still causes many problems with intersections and unwanted gaps.

This design is a continuation of the previous form, but is placed even more linearly to fix the problems with the gaps. It uses the hexagonal bricks. The main problem is the organization of the interior spaces. You are forced to pass through each program.

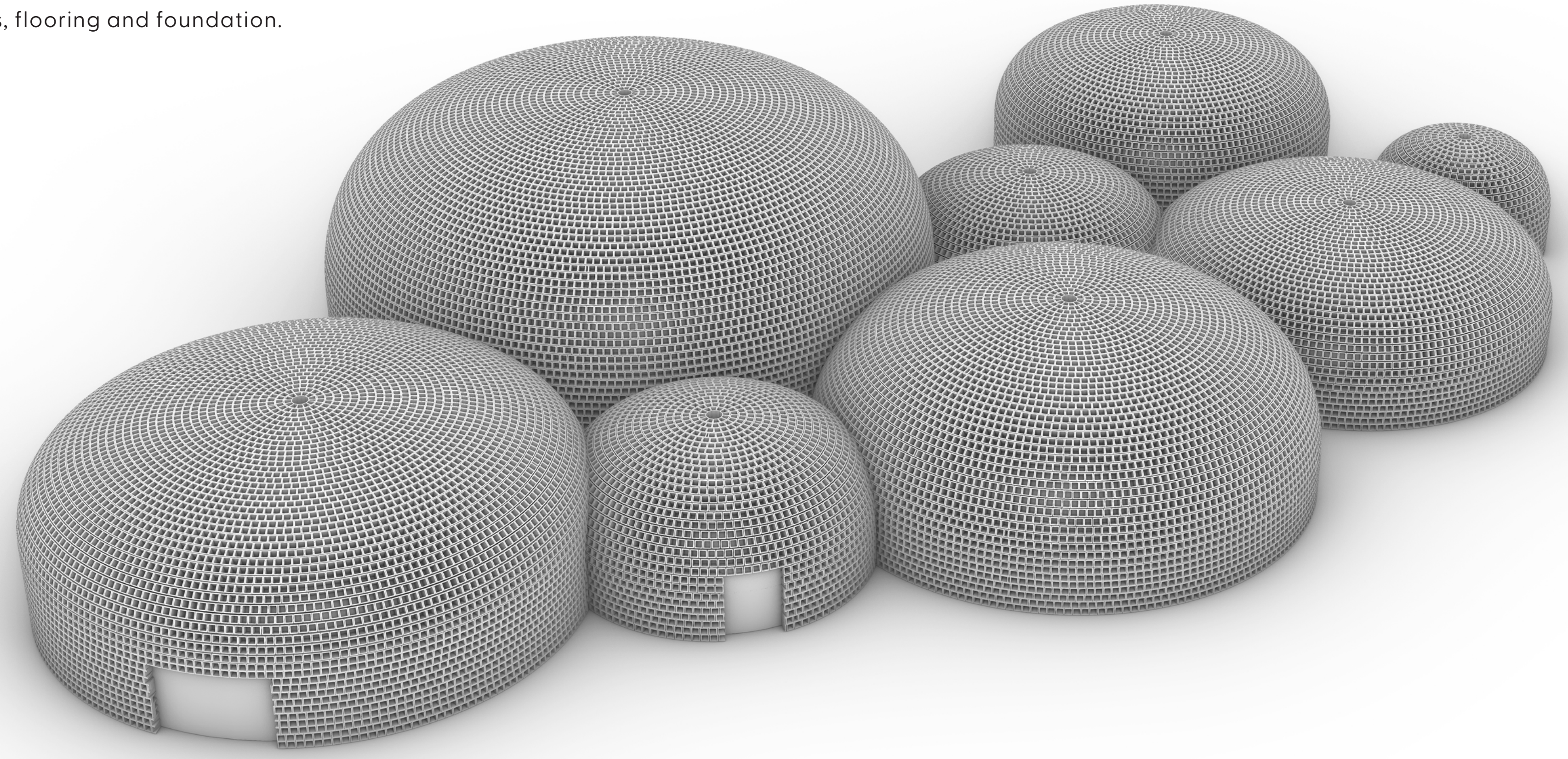


The domes are placed in a connected cluster that intersect and allows easier interior circulation. The problem is the irregularity of the domes as well as the circular openings. It requires larger sets of unique building material, leading to heigher cost and less efficient construction.

CONCEPT

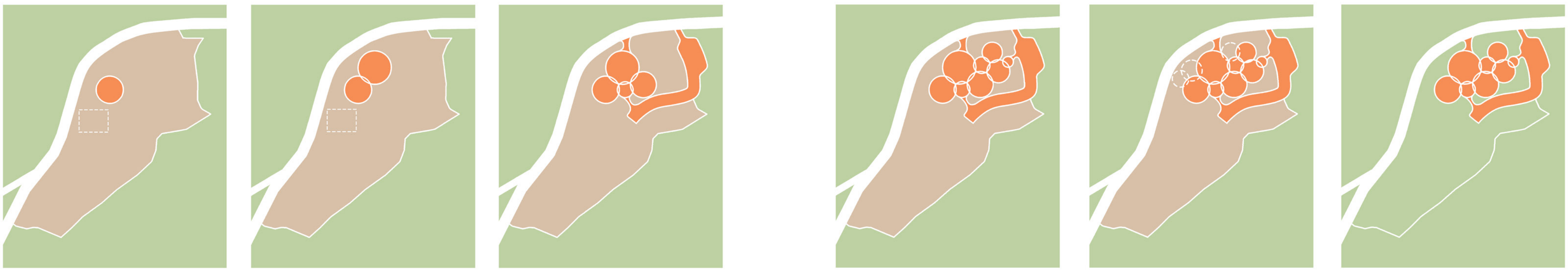
The final concept is a result of the form finding process. It is a cluster of dome structures intersecting to create interior connections between programs. The main reason for the overall form is the material requironments and the structural system. The entire project will be constructed using only recycled waste materials. This includes the load bearing structure, furniture, interior walls, flooring and foundation.

The strength of the concept is that each dome can be constructedonly one dimension of bricks. The structure is very versatile. It can be modified, expanded or otherwise changed in the future, depending on the need of the Stanisce Recycling Center.



STAGES

timeline 2022 2035



1st stage:
Construction of sorting facility.

2nd stage:
Construction of production facility.

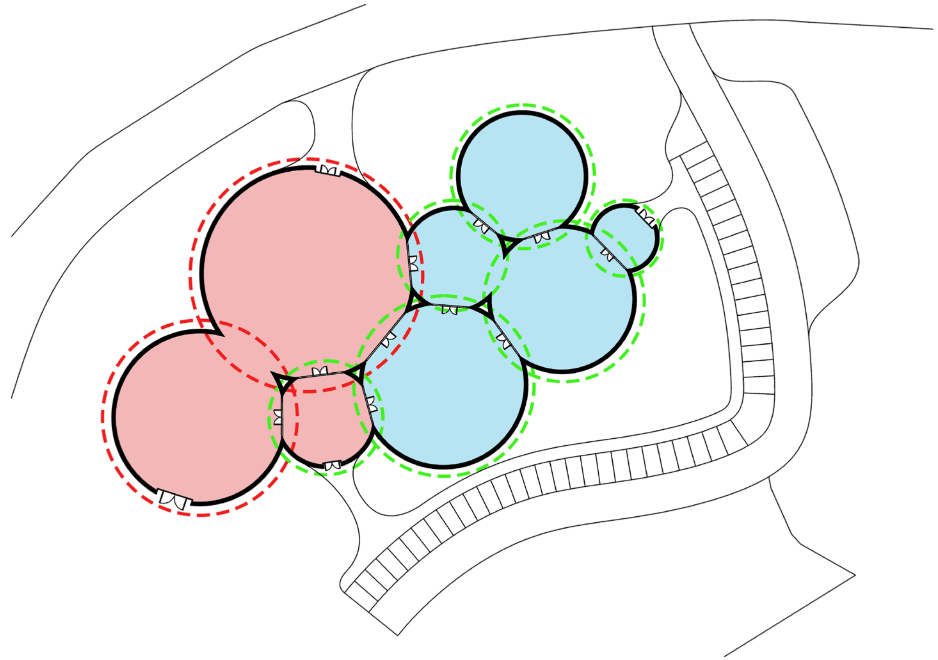
3rd stage:
Construction of research facility and parking.

4th stage:
Construction of exhibition, auditorium, restaurant and main lobby.

5th stage:
Possibility of expansions

6th stage:
Future

ORGANIZATION



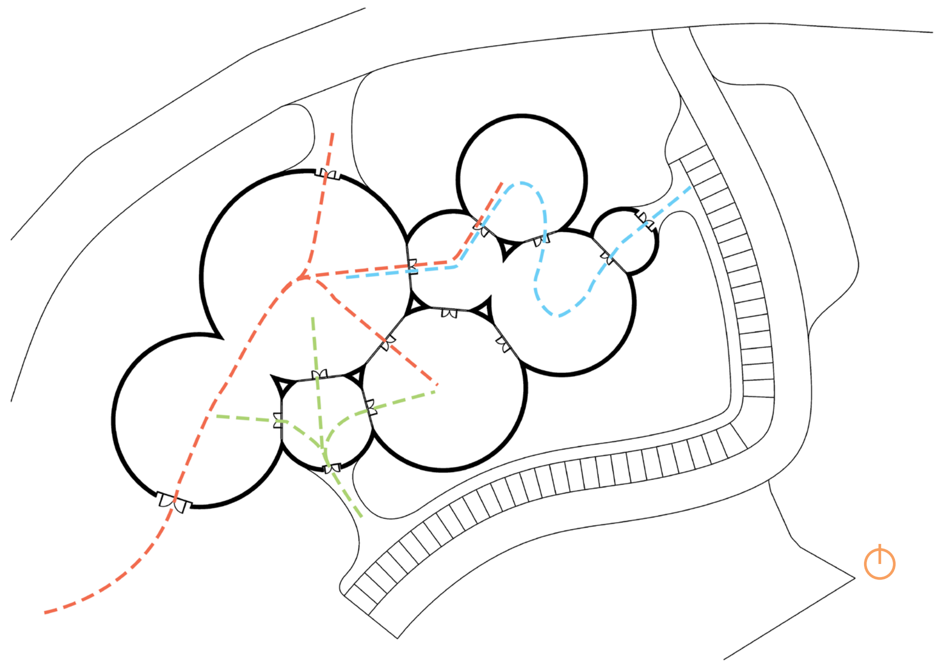
The first map shows the organization of unclean and clean zones as well as division of public and private programs.

unclean zone

clean zone

private

public



The second map shows three types of circulation. The waste circulation starts with incoming waste from the landfill. It gets sorted, it turns into material, it is exhibited and researched and lastly it is presented to the public.

The circulation of visitors works in the opposite direction. It starts with education, then exhibition where workshops can be conducted with possibility of entering the production facility to see the process.

waste circulation

circulation of workers

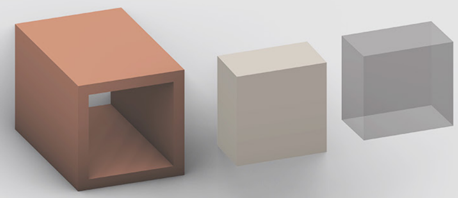
circulation of visitors

THE CONSTRUCTION SYSTEM

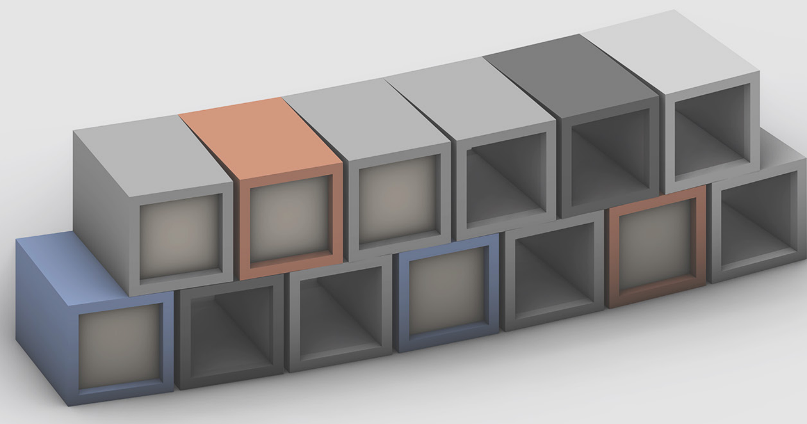
The construction system consists of a structural frame made of recycled plastic in a variety of colors, and the core of the frame which is either mycelium brick made from organic waste or transparent plastic brick. The gap between each brick is filled with paper pulp to create a connected and completely sealed structure.

Each brick has identical dimensions, which allows for fast construction, efficient and cost-effective production as well as a versatile building system that can be used to construct a wide variety of domes.

This system supports the concept of design for disassembly. A structure can be easily assembled and then disassembled in the future in case of changes to the structure or expansions.



Recycled plastic brick frame   Mycelium core   Transparent plastic core

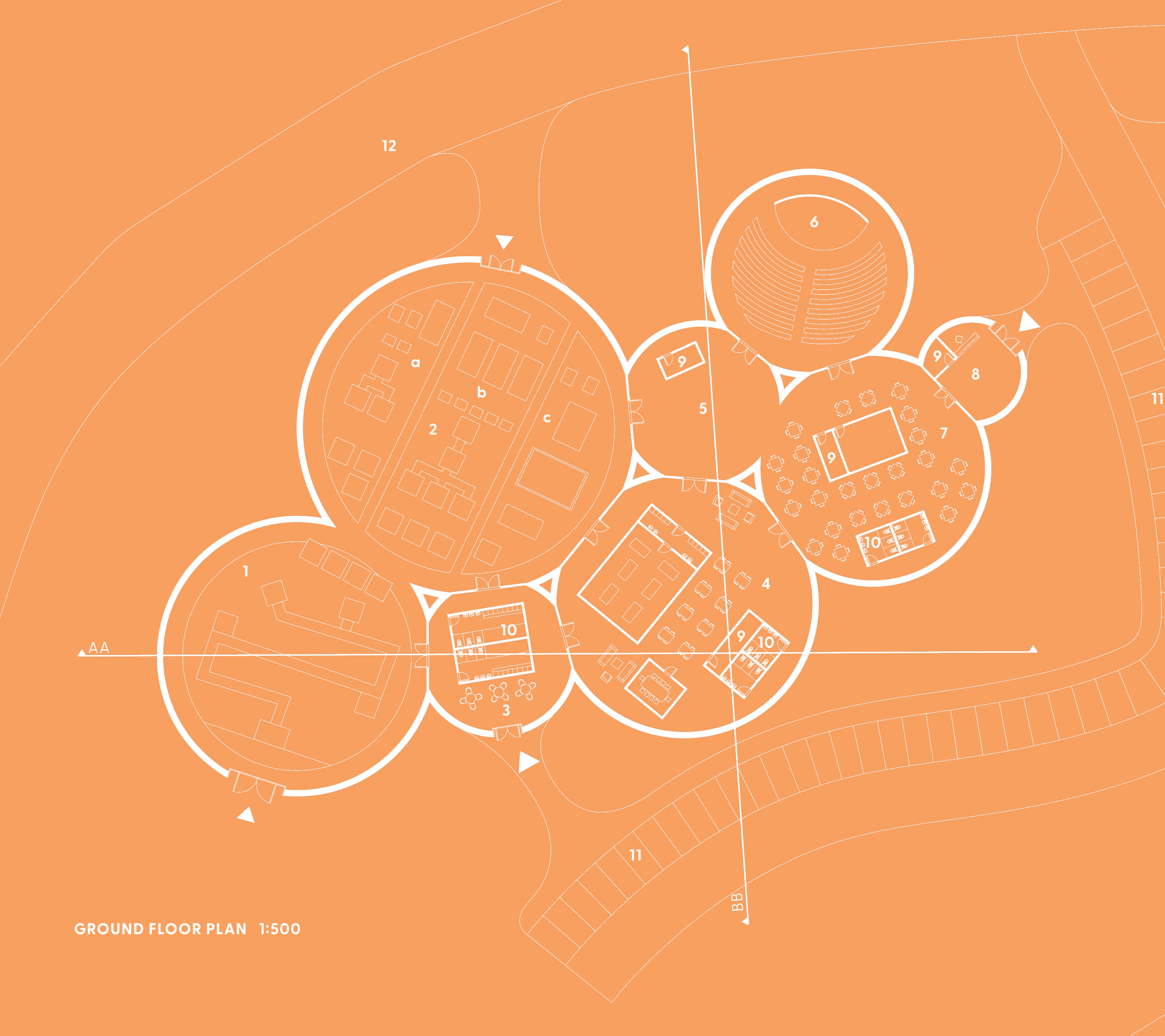


This chapter presents the final state of the Stanisce Recycling Center. It includes site plan, floor plan, elevations, sections, GROWTH furniture design, construction detail and visuals.

DRAWINGS

06

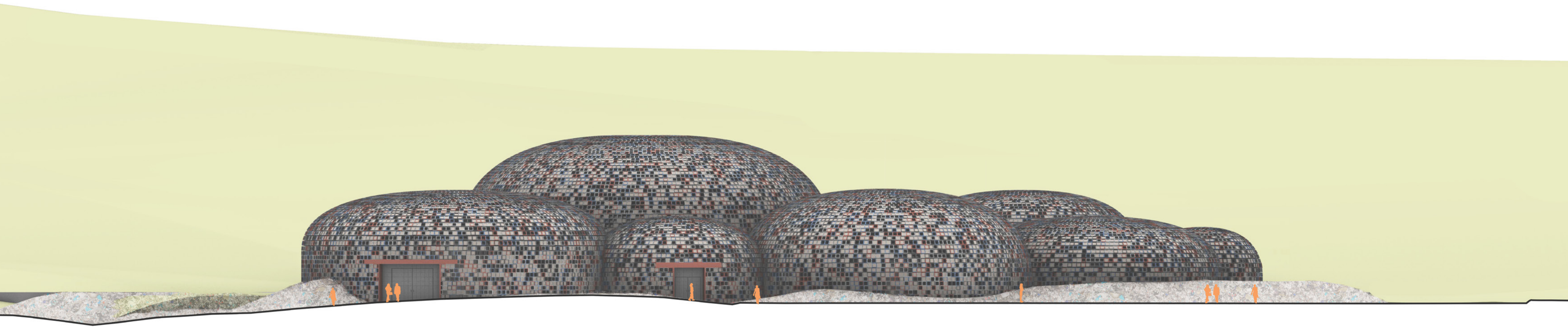
SITE PLAN 1:3000



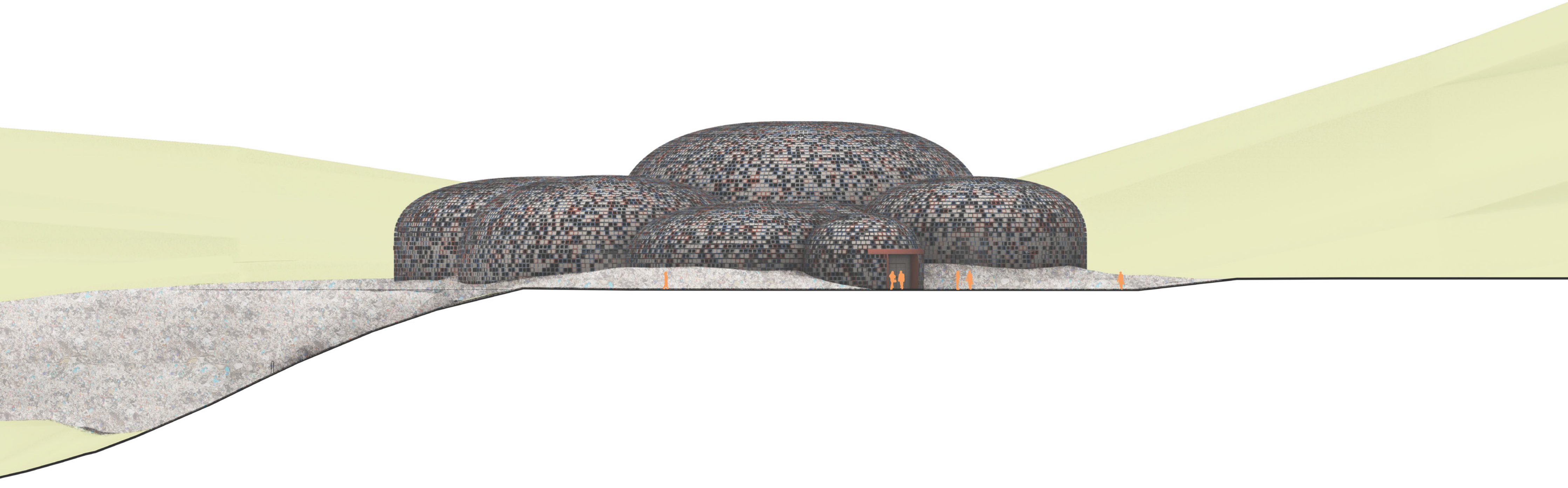
GROUND FLOOR PLAN 1:500

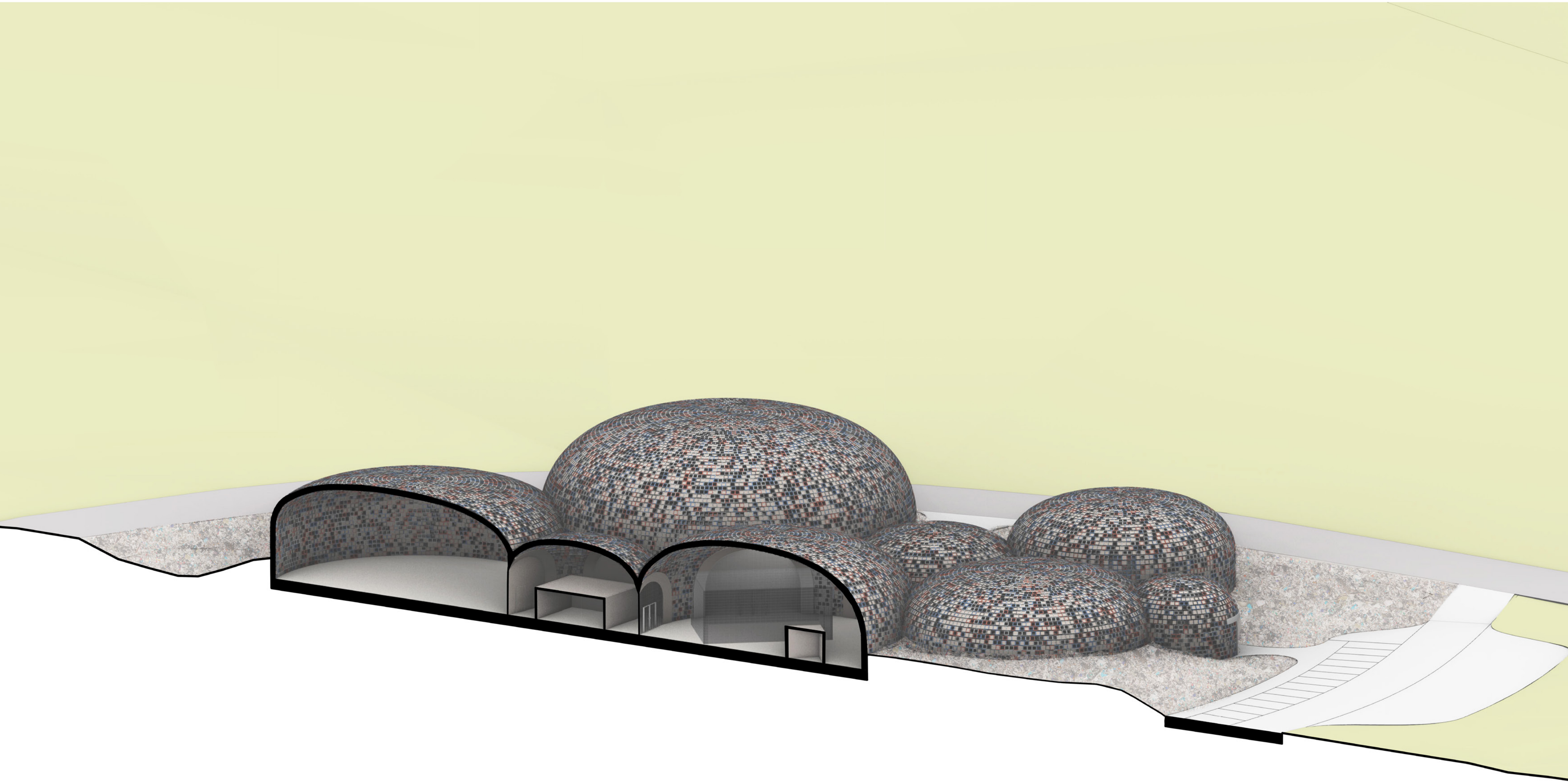
1 Sorting facility
2 Production facility
a. paper/cardboard
b. plastic
c. mycelium
3 Entrance for workers
4 Research facility
5 Exhibition area
6 Auditorium
7 Cafe/Restaurant
8 Main vsitor entrance
9 Storage/Technical space
10 WC
11 Parking
12 Road

SOUTH ELEVATION 1:500



EAST ELEVATION 1:500



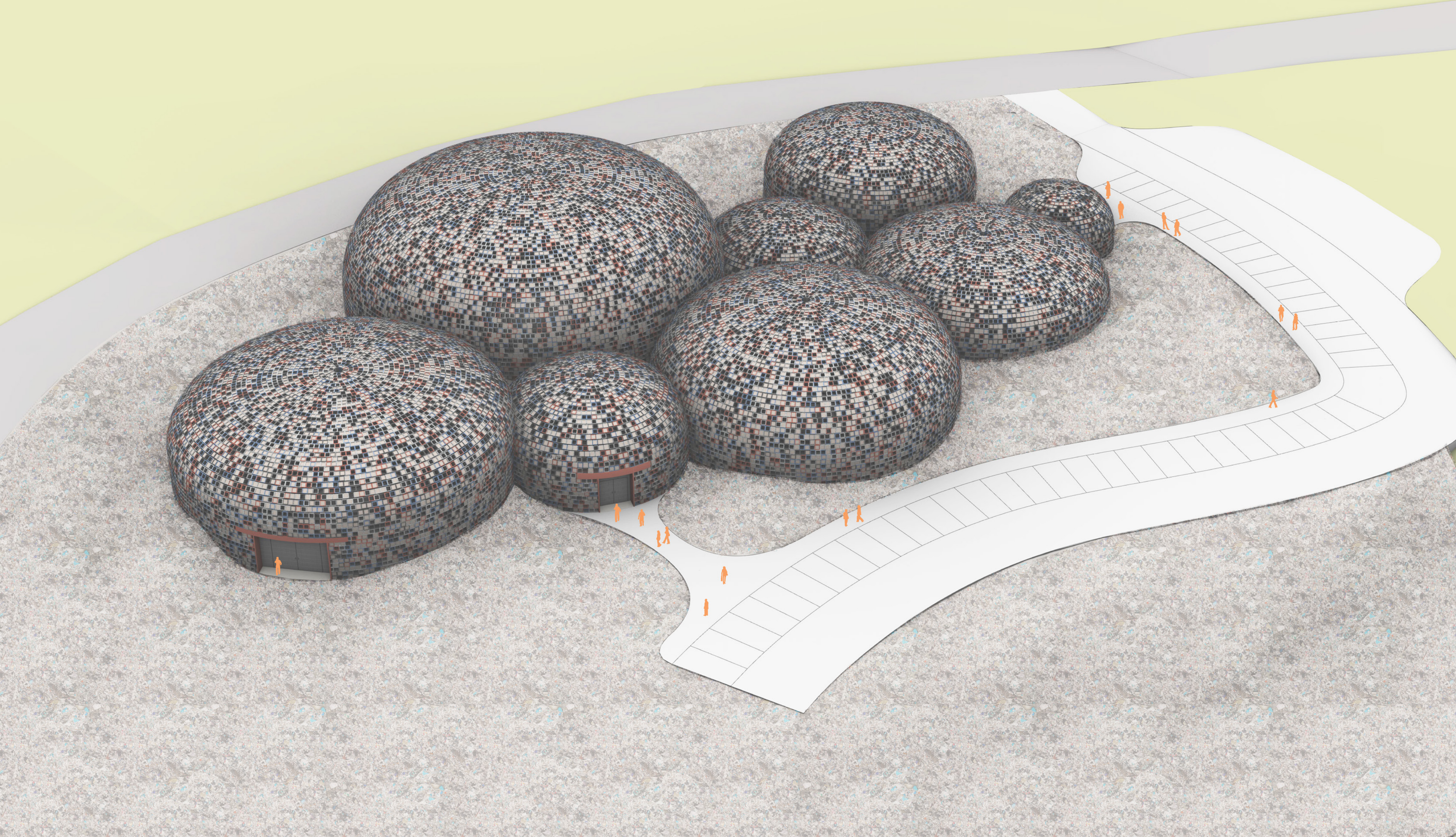


AA SOUTH 3D SECTION 1:500

BB EAST 3D SECTION 1:500

AXONOMETRY

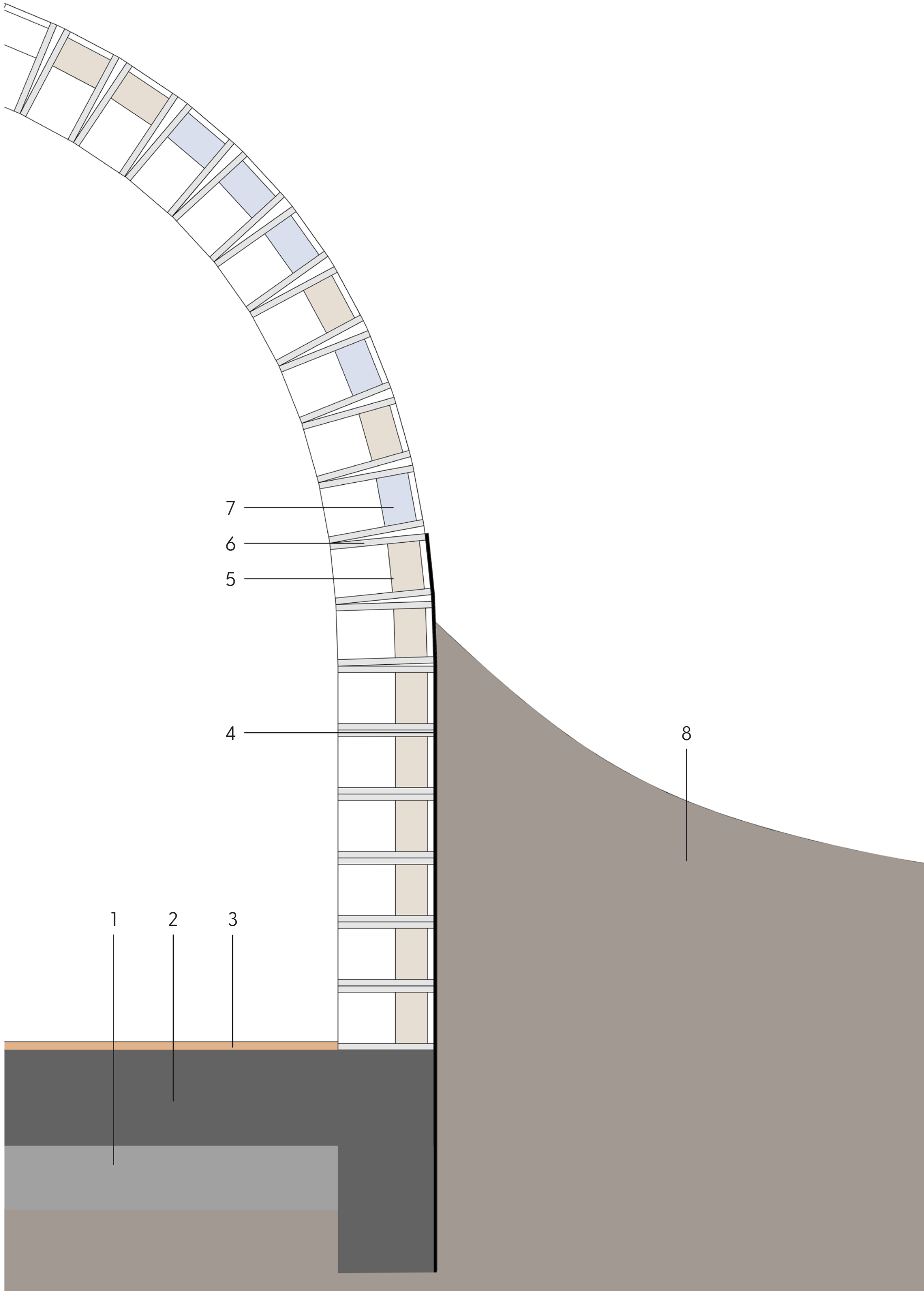
AXONOMETRY



CONSTRUCTION DETAIL

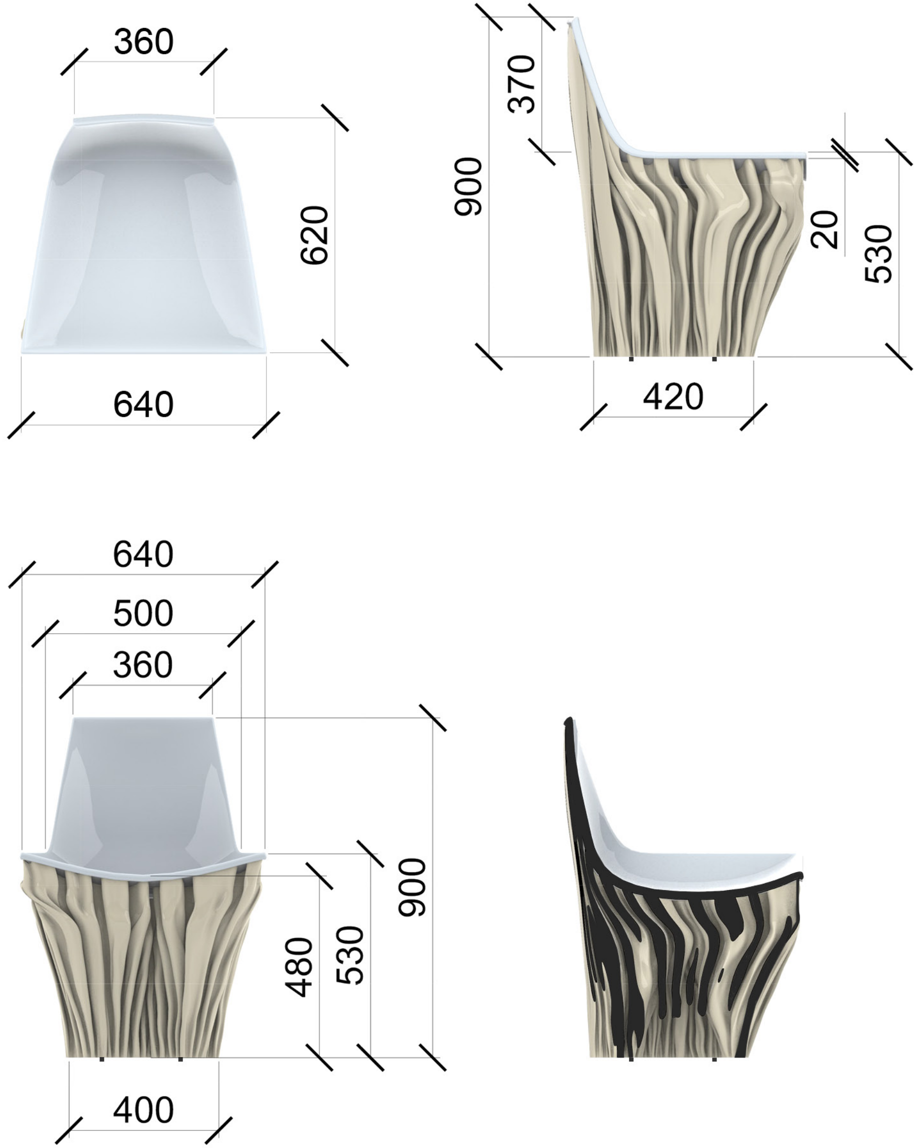
1:30

1 Plastic Aggregate
2 Paper Pulp Foundation
3 Plastic Floor Panel
4 Plastic Vapour Barrier
5 Mycelium Core
6 Plastic Brick Frame 400mm x 400mm x 600mm
7 Transparent Plastic Core
8 Landfill



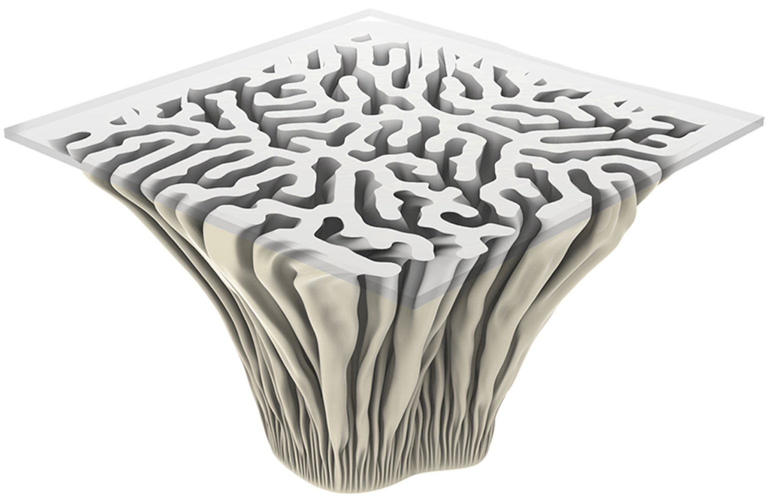
ARCHITECTURAL DETAIL

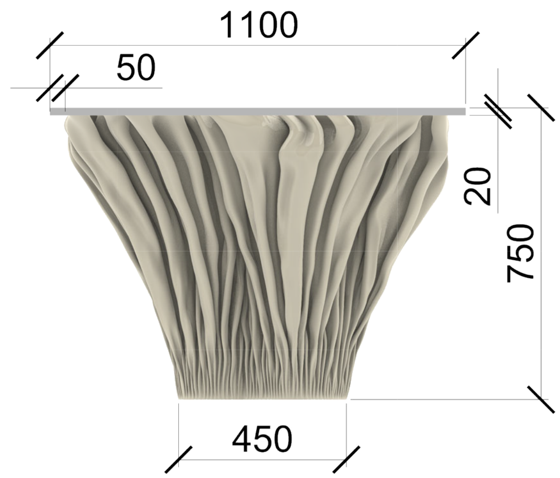
GROWTH is a set of furniture created by recycled landfill waste. It's a combination of 3D printed paper pulp with organic mycelium growth and recycled plastic. The process of making GROWTH furniture starts with the base of the furniture that is using recycled shreded paper. This material is than mixed with water to create paper pulp and than mycelium fungi is added. After that large scale 3D printer prints the base and after 7 days of leting mycelium to grow, it is heat treated to kill the fungi. Top part of the chair is made from recycled plastic and it is using the injection molding process. For the connection of base and top polyurethein or clear resen epox is used.

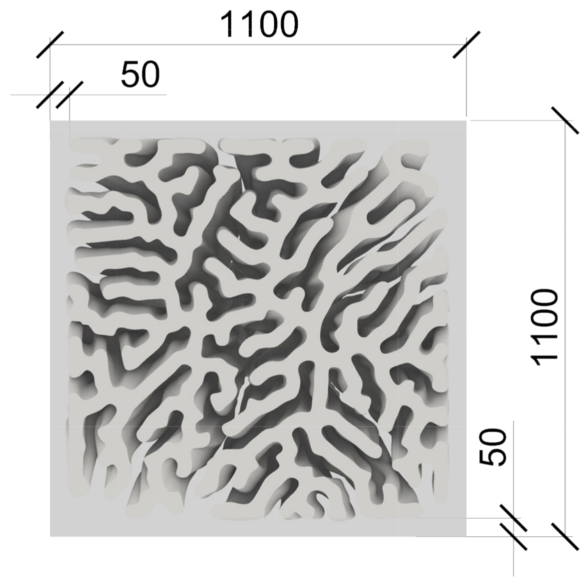


ARCHITECTURAL DETAIL

GROWTH small table that can fit up to 4 chairs.
While for the chair the top part can be made out of different colors, the top of the table is made of more see trough mixture. The reason for that is to be able to see the base and the process of the growth that happened.

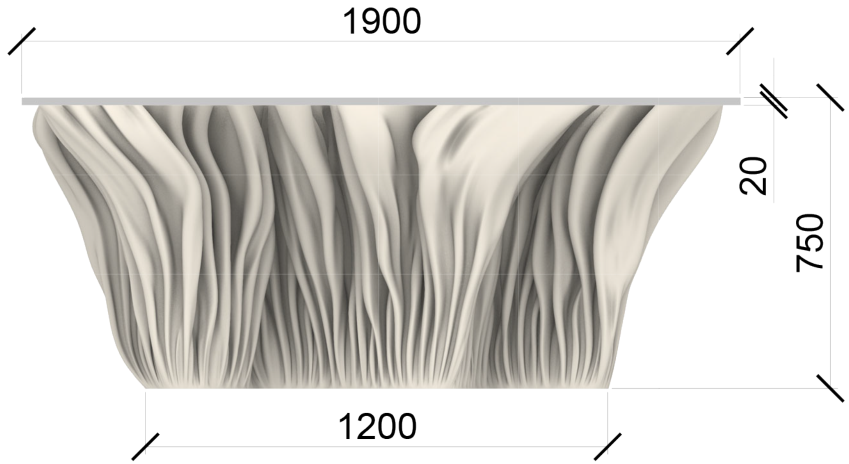


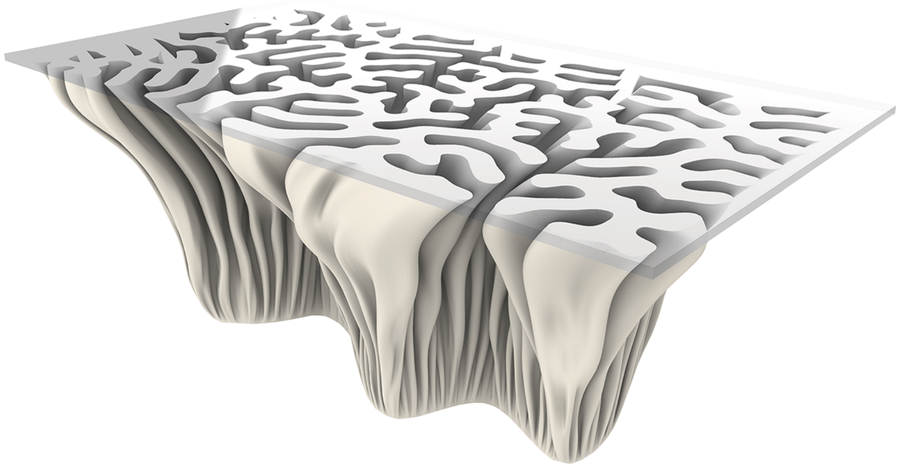


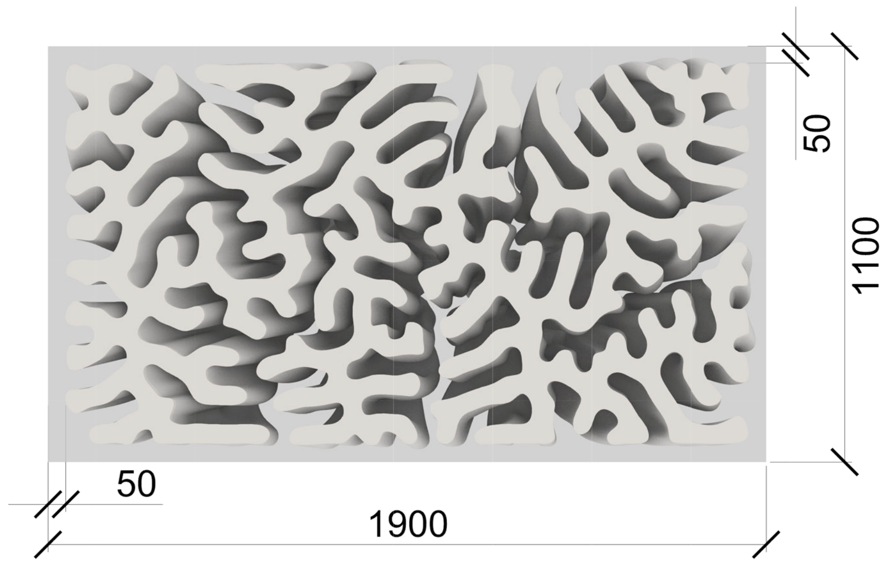


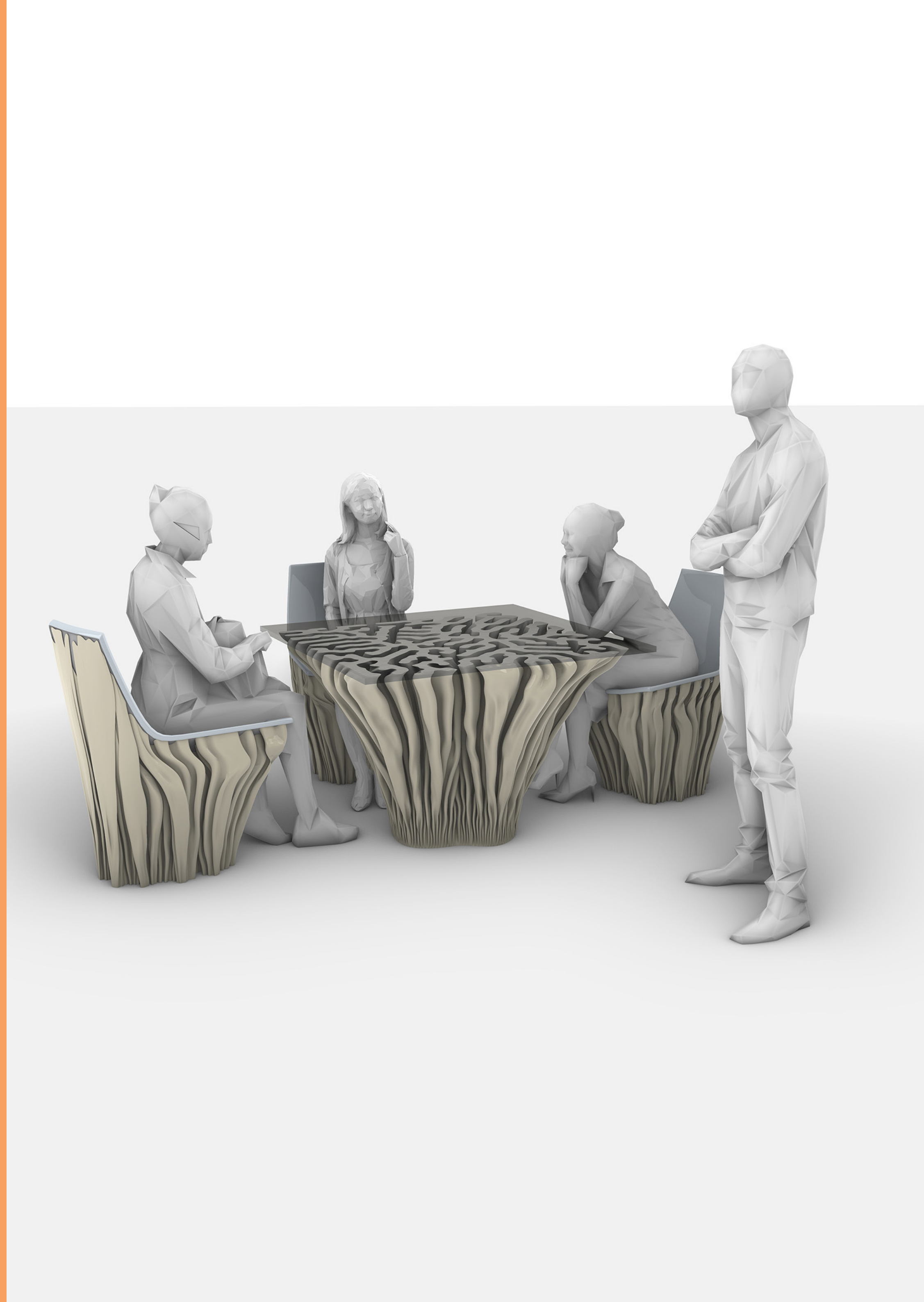
ARCHITECTURAL DETAIL

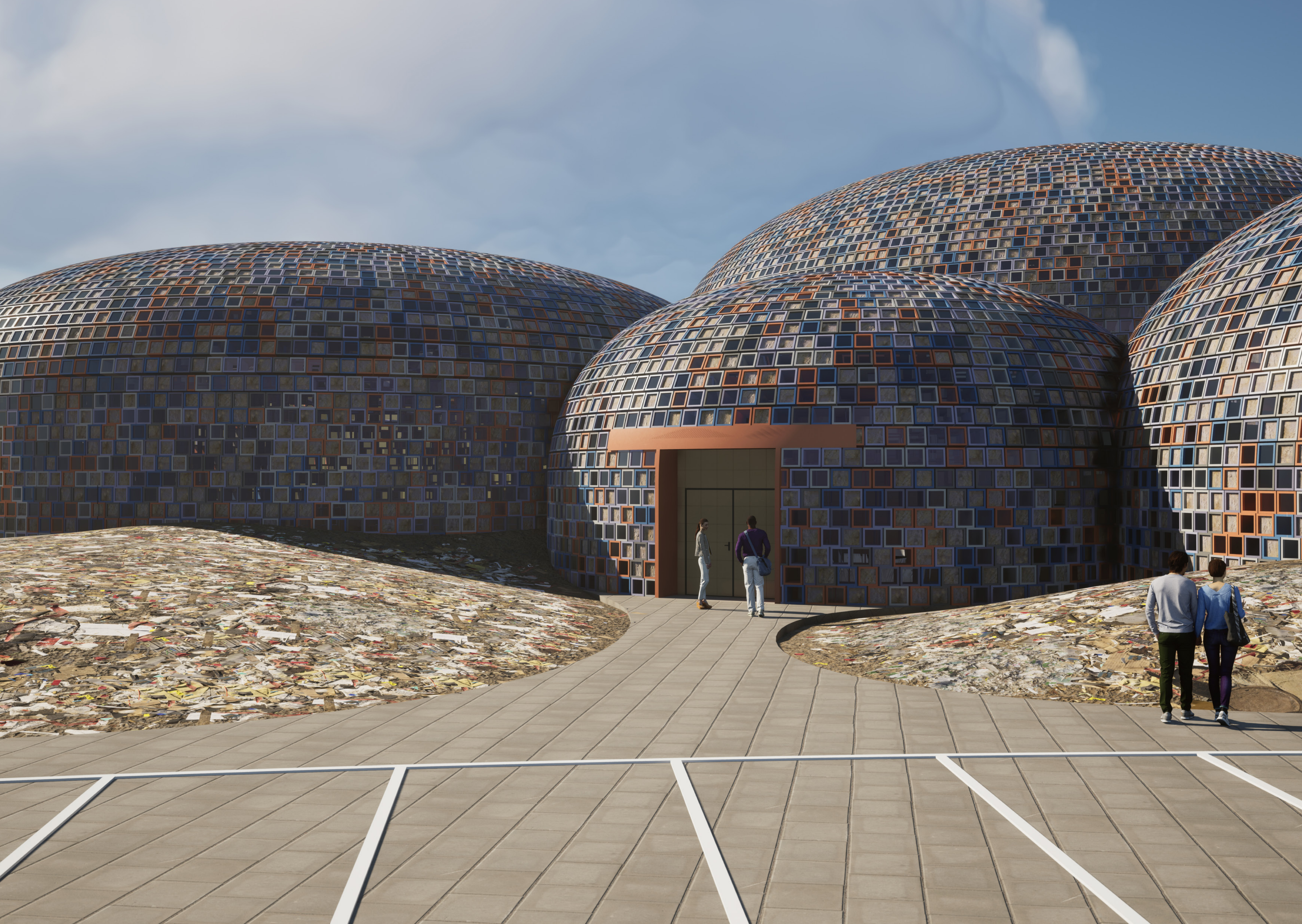
GROWTH large dining table. It can fit up to 6 persons. It is created with the sam eprocess used for small table.



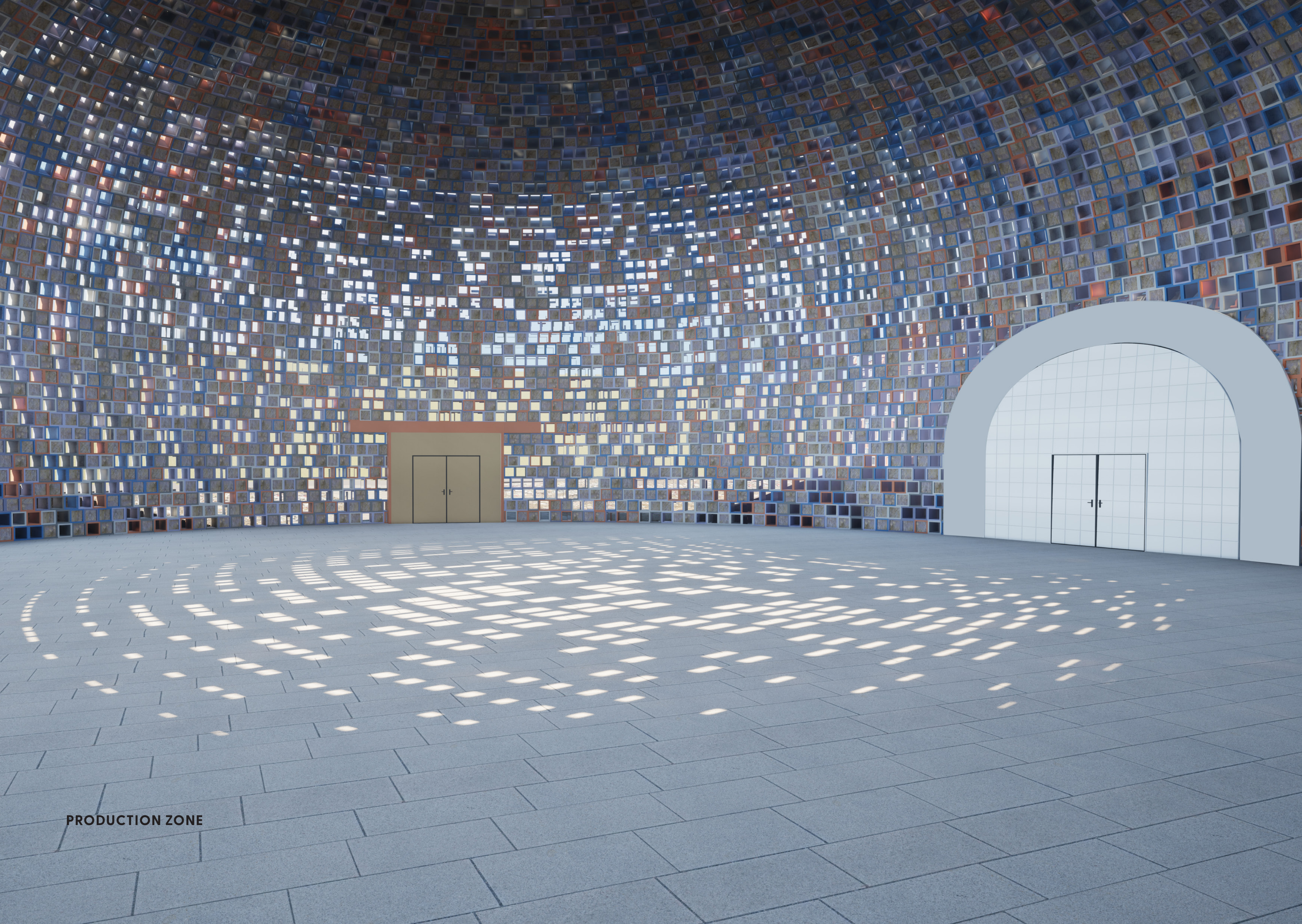




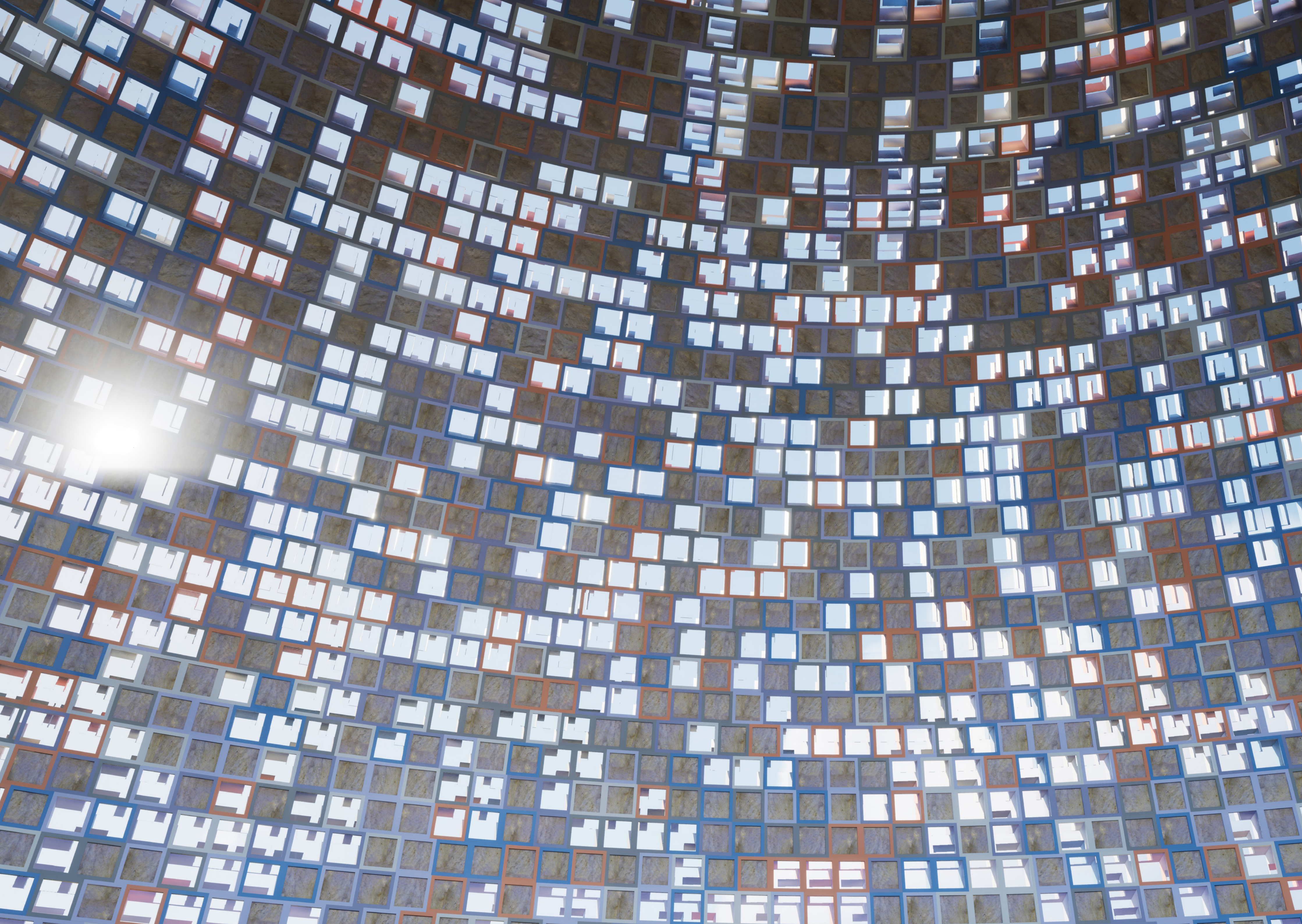




CAFE WITH GROWTH FURNITURE


PRODUCTION ZONE

AUDITORIUM



FUTURE
2035

PHYSICAL MODEL

1:250

BRICKS DETAIL

1:10

TECHNICAL REPORT

07

TECHNICAL REPORT

The Stanisce Recycling Center consists of 8 domes, each containing a variety of programs. Each dome intersect with its neighbour to create fluid interior circulation. The project will be constructed in several stages. The first stage will include the digging and leveling of the ground for the sorting facility. At this stage a temporary production facility will be set up to produce enough material to construct the sorting and production facility. Once the production facility is constructed the temporary facility will be removed and all future production will be conducted within the production facility. After all 8 domes are constructed the waste will be pushed up against the exterior wall of the project to fully plant the building in the landfill. The waste has a secondary function as retaining wall for load bearing construction. In the future the waste in the landfill will be completely replaced by greenery.

The production facility is split into three zones. Each zone will produce one category of building material. The categories are: Paper/Cardboard, Plastic and Mycelium. The production is based on the three biggest categories of waste found in the landfill. The size of the production facility is influenced by the required machinery needed to produce these materials.

The area in front of the entrance for the sorting facility will be leveled to allow trucks to deliver the waste. There is also enough space inside the sorting facility for trucks deliver material.

One unique challenge to this spesific site is smell. The strategy I am using to deal with this issue is to construct entrance domes as a buffer area before entering the main programs.

The project will provide work for 20-30 people. 10-12 people will work in the sorting and production facility. 15-18 people will work in the research facility. 2-3 people will work in the cafe.

The Stanisce Recycling Center will collaborate closely with local schools and universities and function as a knowledge hub. There will be many educational events with workshops where visitors can experience and make something out of the waste material.

CONCLUSION

08

The Stanisce Recycling Center is a catalyst project presenting the unique abilities and properties of recycled waste materials. The project is fully constructed of recycled waste materials. The building solves all the negative effects of the landfill by completely transforming the waste into valuable resources over time. The final goal of this project is to fully utilize all the waste and eventually bring back the greenery that was once there.

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