KES 57

DOCUMENTATION

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The White Marble Project
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Unibz
Lasa Marmo

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Abstract

Marble: difficult and unique material. Marble can explain the evolution of human beings in its extraction and processing. Today, it proves to be an unsustainable material, being used globally at overly high standards.

Working with marble is an arduous task for a designer who knows its background. The easy ways are the most common, which entail not only excellent aesthetic and qualitative results, but also production techniques that look towards a consumerist society and a linear economy. To make such a stone sustainable would imply stopping mining, leaving a gap in its economy that would be difficult to fill with a similar material.

Finding a new path is impossible unless one is prepared to encounter some pitfalls on the way. The marble industry favours the aesthetic and performance qualities of its material. Consequently, waste in the production of finished products is numerous and often unused. Making this problem the starting point for alternative marble processing is indeed cathartic.

The filter idea begins with an awareness of the microparticles and dust that are expelled during marble processing. From this starting point, the design of a filter led to the creation of a water filter/mineraliser. Through the use of stones of different sizes, the water flowing through takes up mainly calcium carbonate, which mineral stimulates the growth and care of the vegetal world.

Content page

RESEARCH

Research to understand what marble is, to learn whether we know enough about it, to know its advantages and disadvantages, and to use any information deduced for the following stages.

Excursion

The first step, crucial to understand marble, was taken during an excursion to Lasa, visiting Lasa Marmo. This company is one of the most important extractors, producers and exporters of white marble, renowned for its purity and strength, given by an excellent crystalline structure.

During the visit, after having explored the quarry, in the heart of the mountain and having realised the origin of the stone, it was possible to take a closer look at its processing, its preservation and its place on the market. At the same time, the view of no small mountain of waste, preserved after processing, is also impressive.

The excursion to Lasa and to the adjacent villages demonstrated the urban use of white marble, in statues, paving, barriers, fountains and artefacts in private gardens. This illustrates a frequent use of this stone in the most varied categories, from the simplest to the most elaborate and special.

Next page: Mountains of waste of marble in front of the Dolomites

End part of an excavator inside the quarry

Machine used for the cutting of marble blocks within the quarry

Detail of the smooth wall after the removal of the blocks inside the quarry

Circular saw used to square marble slabs and blocks

Remains of Lasa marble artefacts scattered in the city’s residential gardens

Lasa marble column in a residential garden

Limited resource

The first phase of the research was carried out in groups. It should be noted that the choice of topic was made out of general interest without having a clear idea of the final output. Together with the colleagues, the research was conducted starting with the question of the finite nature of marble as a resource, hence its sustainability.

Marble, in relation to human beings, is infinite in quantity. It would be impossible to deprive the earth of every marble sediment. What is influential is the difficulty in extracting it, which would trigger a chain reaction, increasing costs and decreasing demand. According to geology professor Stephen Marshak of the University of Illinois, ‘running out is an economic concept’.

There are two types of marble extraction. While it is difficult to say that one is fairer than the other, it is possible to relate the pros and cons to determine which is the least dangerous. The first method is defined by the open quarry, the biggest example in Italy being Carrara. This method excavates the mountain in its entirety, dismantling stone even from the surface. The second method, more sustainable than the first for having a significantly lower environmental impact, is the one used in Lasa. The quarry is hidden in the mountain, developing inside, preserving the surface.

The sustainability of each material depends on several factors. That of marble is compromised mainly by three factors. Environmental impact, which includes visual impact, noise impact, impact on animal and plant habitats, and water and soil pollution. This takes into account quarrying and extraction activities. As a consequence of extraction and processing there is a large production of waste. The most dangerous is certainly dust, which causes flooding and air pollution. Finally, all activities orbiting the marble world have a high energy impact.

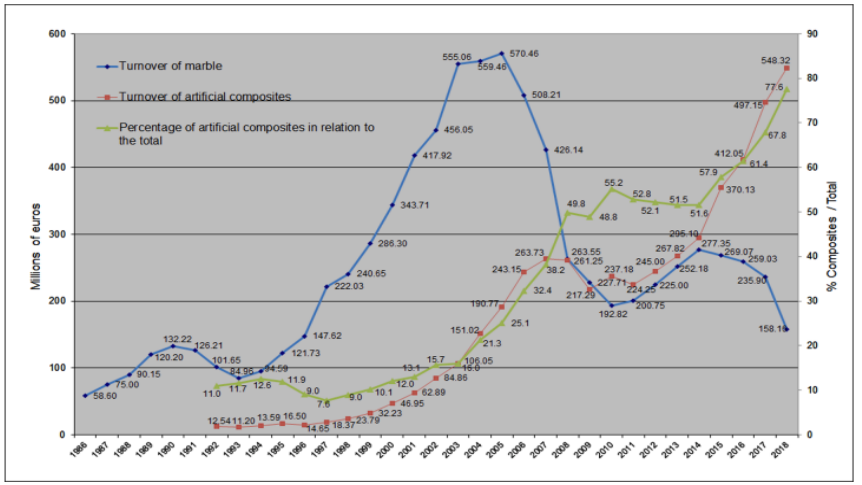
Marble value

The value of marble is related to numerous factors. It depends mainly on economic, social and cultural factors.

The society and culture of a particular place influences, for example, the relationship people have with long-lasting artefacts such as statues and fountains. In addition to this, society and culture are closely associated to industry, which has a strong economic impact.

An example is demonstrated by the Macael region in southern Spain. In addition to the extraction and subsequent processing activities, which influence the economic and/or social value of marble, the design of an ‘alternative’ marble can also change the variables described above.

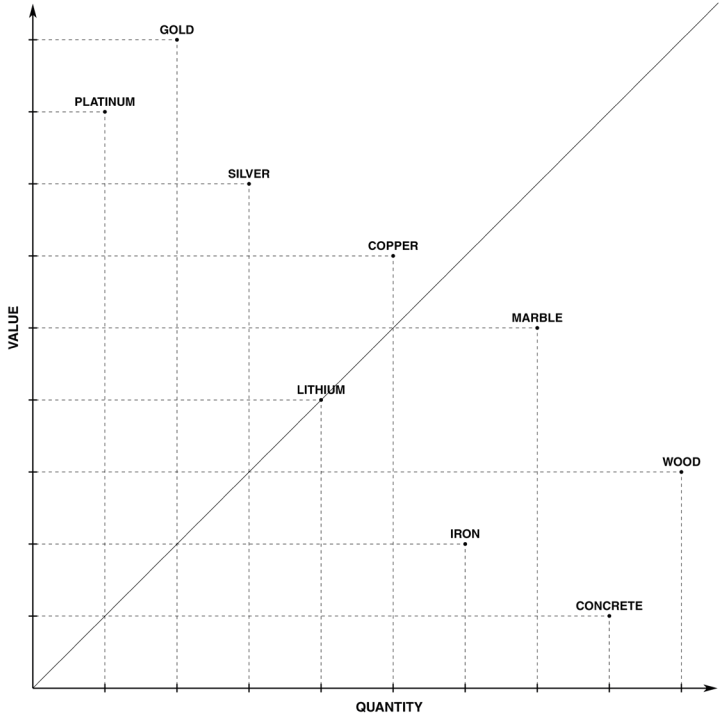
Two companies have stood out for their relationship with marble.
Adoro, a Spanish company, developed the ‘master plan for marble’, transforming and improving the economy of the marble industry after the 1983 Global Action Plan. This plan created ‘exploitaition units’, organising mines, deposits, industry and security, and transformed the waste management of the marble quarrying industry.
The Cosentino company, on the other hand, revolutionised the region through the creation of synthetic marbles that turned the market upside down and decreased the excessive extraction of stone from the mountains. The pioneering products are ‘Silestone’ and ‘Dekton’.

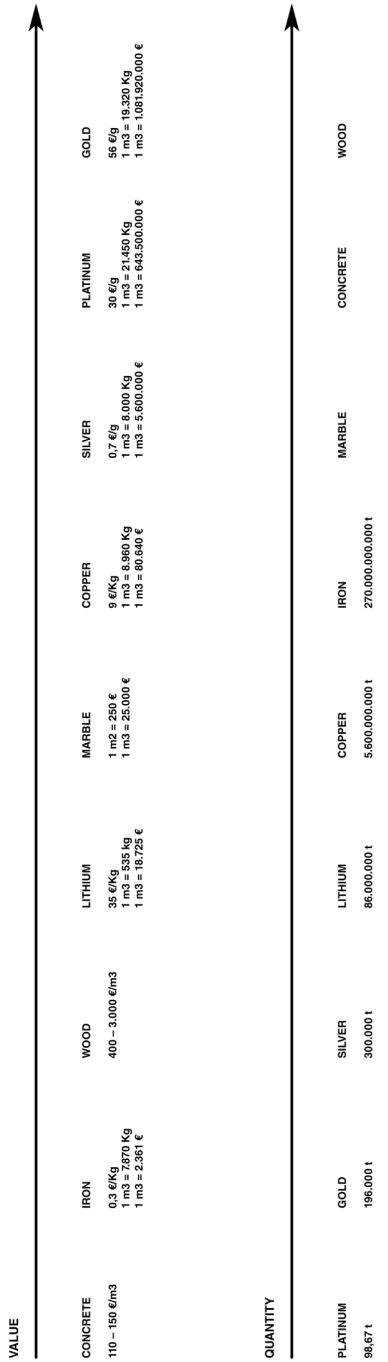


Macael Marble District. Turnover for marble and artificial composites

Parallel to research on the existing economic and labour system, I carried out a research with my colleagues on the value of marble and its relationship to other materials.

The research was based on discovering the specific weight of each material, calculating the price per cubic metre and finally a study on the environmental availability of each material. At the end of this research, we transformed into graphs a ranking, which respected value terms.





DESIGN PROCESS

The next step is to have a working concept, which can be achieved through experiments, prototypes and drawings.

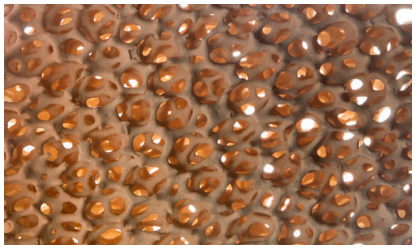
Marble filter

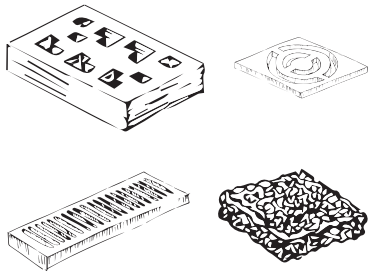
A filter can be used as a barrier for various ‘substances’. The main examples are air, water, or other liquids, and light.

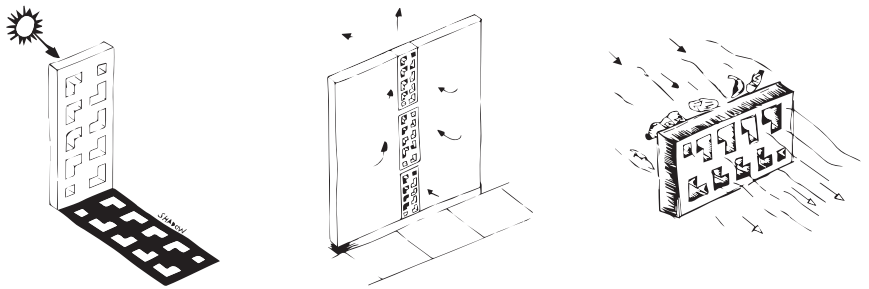
The first idea for creating a marble filter was to simulate the process used to create ceramic filters. These filters are used for their resistance to very high temperatures and consist of a foam coated with a thin layer of clay that is baked to harden and endure. To create what could be called marble foam, marble powder mixed with water and cement would have to be substituted for the clay.

At the same time, I considered another, simpler type of filter. It consists of a block of casted marble powder with holes arranged geometrically on the surface. The purpose for these blocks is varied. They can be used to cover aeration devices on facades or interiors, they can be used as barriers in water courses to block medium to large waste, or they can be implemented in walls and facades to create visual effects with light and shadow and implement a method of natural ventilation inside the building.

The carrara block is a brick made of recycled marble powder mixed with cement and pressed into special moulds, produced by the start up CATALYST.







Top left and right: LANIK foam ceramic filter

4 drawings middle: Possible marble filters ideas

3 drawing bottom: A filter in different enviroment, releation with different fluids

Concrete foam

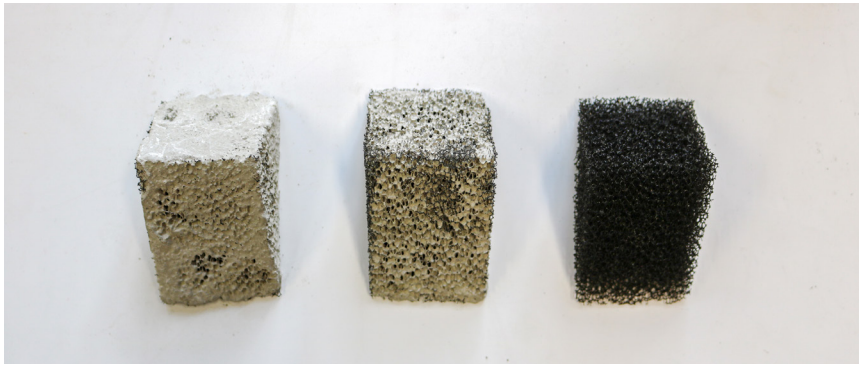
Since I was not sure of the components to make a solid material using marble powder, I decided to experiment with cement to create a concrete foam. As a rule, cement should be mixed with water in a ratio of 2 to 1.
For this experiment I used three different foams, the first made of cellulose for dishwashing, the second with larger pores and therefore less dense, and the third with a more regular matrix, used as a filter in aquariums and more importantly the type of foam assumed to be used for the creation of ceramic foam. The concrete was mixed with water at a ratio of 1 to 1 so as to make it more liquid than normal. Two sponges of each type were dipped into the mixture.
One sponge of all three types was dipped twice.

Thesis:

Foam 1 - The concrete did not penetrate the material in either case. The sponge dipped once is still soft when pressed. (Top)

Foam 2 - The concrete penetrated the sponge slightly, turning the sponge dipped twice into a solid block and the sponge dipped once slightly less solid. (middle)

Foam 3 - The cement penetrated the sponge almost completely, especially on the second attempt, creating what could be called concrete foam. The block, however, is very brittle and friable, assuming a disappointing result if the cement were replaced with marble. (Bottom)



Marble in agriculture

Marble is a rock composed mainly of calcium carbonate. This mineral, like many others, has the ability to alter the PH of water. PH is a scale that defines the acidity or basicity of a solution. Calcium carbonate when mixed with water increases the PH of the water. According to some studies, this increase would make the water used to irrigate plants and fields perform better.

For empirical proof, I developed a simple experiment. Three carrot heads and three containers.

Day 1 - The first container has marble stones of different sizes. All three containers are filled with water until part of the carrot is left in the air.

Day 7 - The carrot in the first container (with marble stones) shows the start of a plant. The second and the third container has not change.

Day 14 - The first carrot is growing a little plant. The second carrot has now the same start of plant of the first carrot last week. The third carrot has not change.

Day 21 - The first plant is growing fast. the second plant follows the first with a slower pace. The third carrot is still not growing.

Day 28 - The first plant has grown faster than the second plant showing the efficiency of the calcium carbonate. The third carrot seems to be dead due to force majeure.

Day 1


Day 7



Day 14



Day 21


Day 28


Carrot sprout watered with mineralised water

Carrot sprout watered with tap water

Crunchy

Crunchy is a machine capable of crushing stones and glass. A block moves against another iron block, slamming the stone between the two surfaces. The pieces fall into different sizes and are sieved and divided according to size. Through this method, in addition to significantly reducing the size of a stone, it is possible to create a fine marble powder.

Crunchy machine


CRUNCHY

Model 1

The first cardboard prototype for a filter has a very simple and rudimentary form. It consists of three small boxes perforated at the bottom with holes of different diameters (from largest to smallest, from top to bottom). Each box contains marble stones, grouped according to their size. This small stack of containers is covered by a grid.

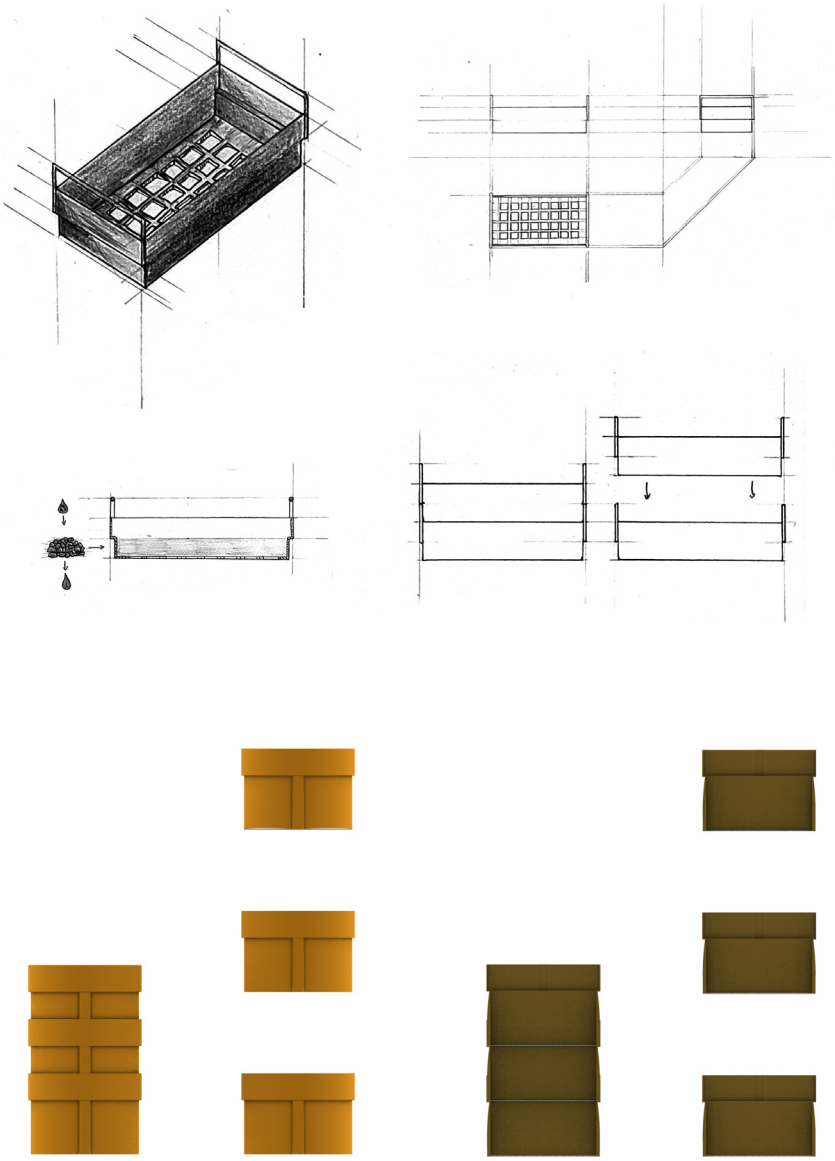
This first idea was intended for use in outdoor places, to filter water full of impurities, by placing it in the floor, for instance in a shower. The stones have the role of filtering, foreign bodies, such as leaves and insects.

First ideas

The first ideas for shaping a filter followed the realisation of the first prototype, through the layering of diverse marble stones. There were two main uses and two shapes designed in this first round of ideas.

The first consists of stacking three boxes with a perforated panel on the bottom with a different matrix. The purpose of this pillar is a simple purification of water from external bodies of different sizes.

The second design of smaller dimensions is intended to be implemented directly into the hydraulic drainage systems of homes. Square or rectangular in shape, three bodies are piled up to perform the same function as the previous concept and then inserted inside the pipes.



Top: First concept. Drawings

Bottom: Second concept. Rhino models

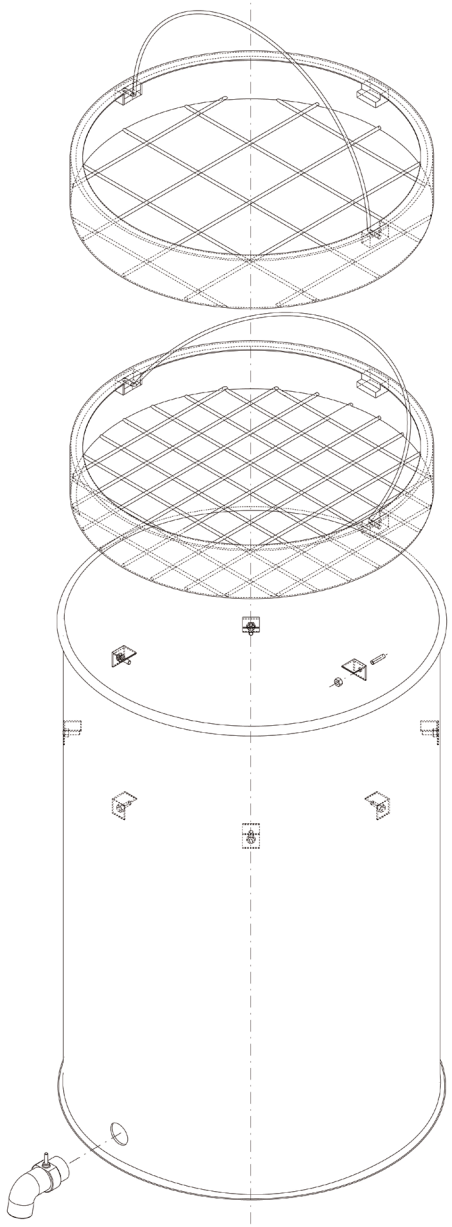
Model 2

The second cardboard prototype, more realistic and detailed than the first, comes close to the final design. The model represents, on a scale of 1:2, a barrel with a diameter of 60 cm and a height of 85 cm. Inside the barrel are several vessels which, as in the first prototype, contain marble stones, used to filter the water. An important feature of this design is the possibility of storing several litres of water inside the barrel.

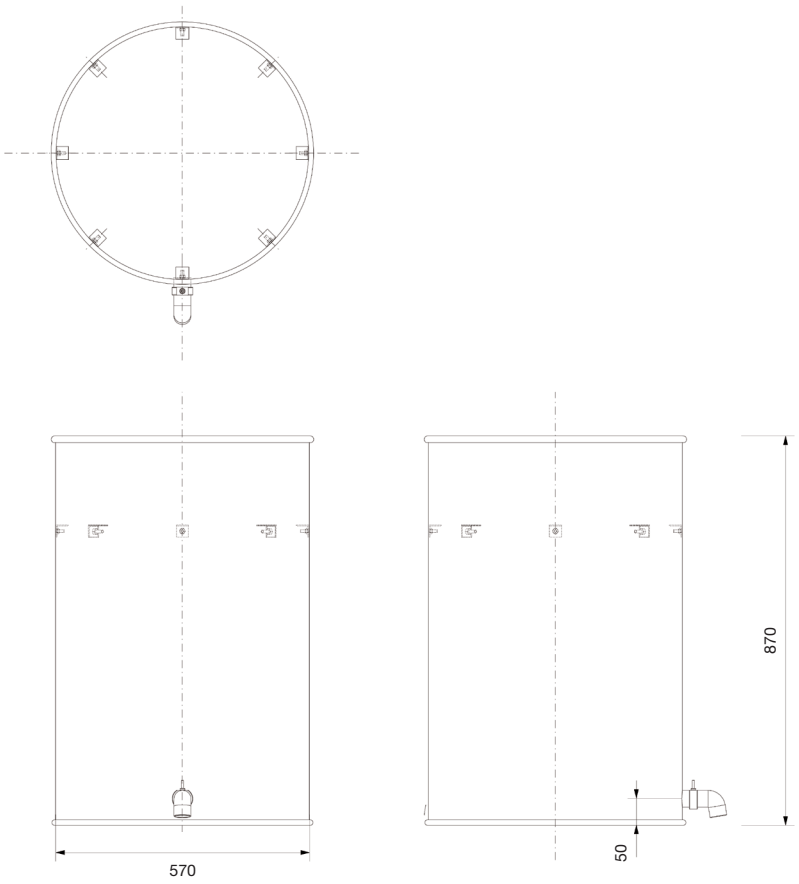
After the construction of this model, questions emerged, that pushed me towards the final design, among them: methods of connection to hydraulic systems, amount of water possible to contain, water withdrawal, maintenance, etc.

Final design

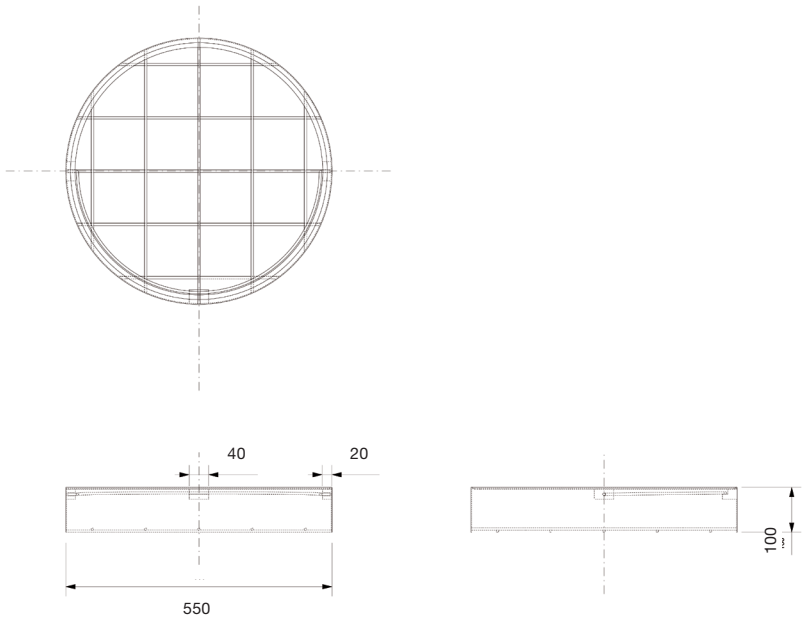
The final design consists of a barrel 57 cm in diameter and 87 cm high. At the bottom a faucet to draw mineralised water when needed. Inside the barrel, two containers, with a wire mesh at the bottom. The nets with different matrixes hold the stones. The two containers have a handle, to facilitate extraction and the maintenance of the system.



Explosion of the drum. Technical drawing



Dimensions of the drum. Technical drawing



Dimensions of the containers. Technical drawing

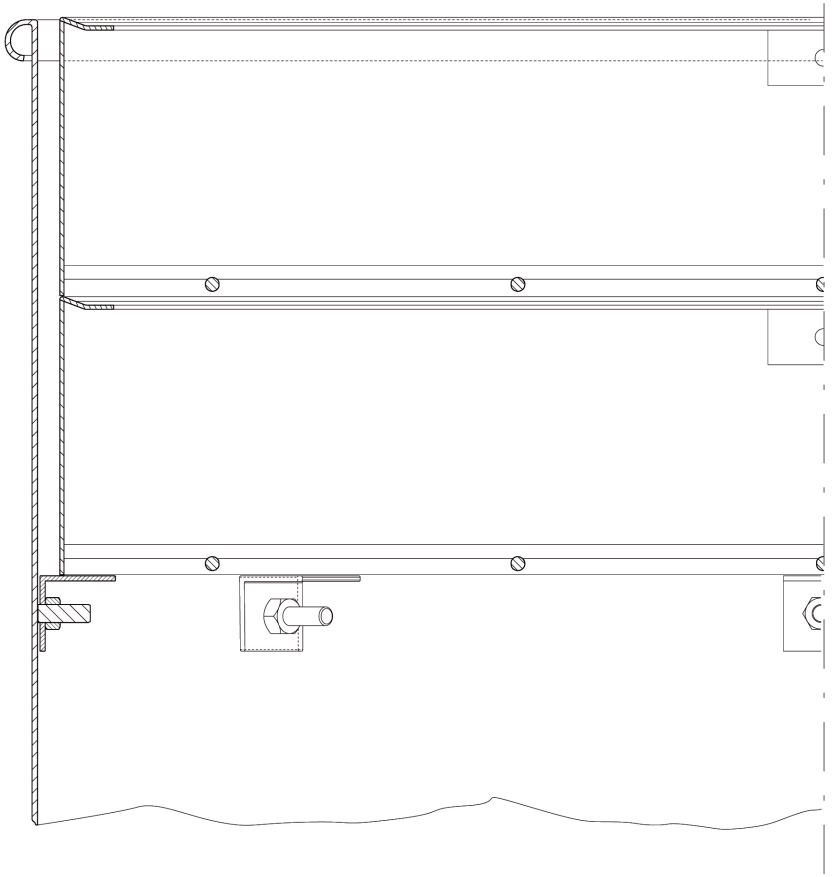
How does it work

The drum performs two functions. Filtration and mineralisation of rainwater, in order of succession.

The top of the drum for a height of 20 centimetres is filled with two trays. Both vessels are filled with marble waste in the raw stone form.
The upper tray contains larger stones than the lower one. This part of the barrel performs the function of filtering: rainwater falls into the barrel, which is open on the upper base, and passing through the stones gets rid of relatively large extraneous bodies.

The lower part of the drum, which is the largest, not only has the task of containing a significant amount of water (about 140 litres), but also features other raw marble waste at the bottom, including dust and extremely small stones.
This layer is continuously immersed in the water and is able to provide the water with a good amount of calcium carbonate.

The now mineralised water can be extracted from the drum through the faucet positioned at a height of 5 centimetres from the bottom base.



Inside of the drum. Technical drawing, section

Work in progress

The entire project was realised by recycling two drums used for storing ink. The drums, once emptied, are regularly destined for landfill, without being reused. This is why I placed great emphasis on using only material from the drums, with small exceptions such as screws and laths.

One of the two drums remained unchanged while the second was used for the construction of the stone trays. The two vessels were made by cutting the drum in strips with a flex, then reducing the circumference and re-welding it, and finally by adding electro-welded mesh and a handle for extraction and maintenance.

The drum, which serves as the casing, also underwent some modifications, but these were almost imperceptible compared to the previous drum. A tap was added a few centimetres from the bottom to allow the extraction of water. Eight screws were electro-welded to the walls of the drum, which allow the attachment of eight brackets that hold the two aforementioned trays.

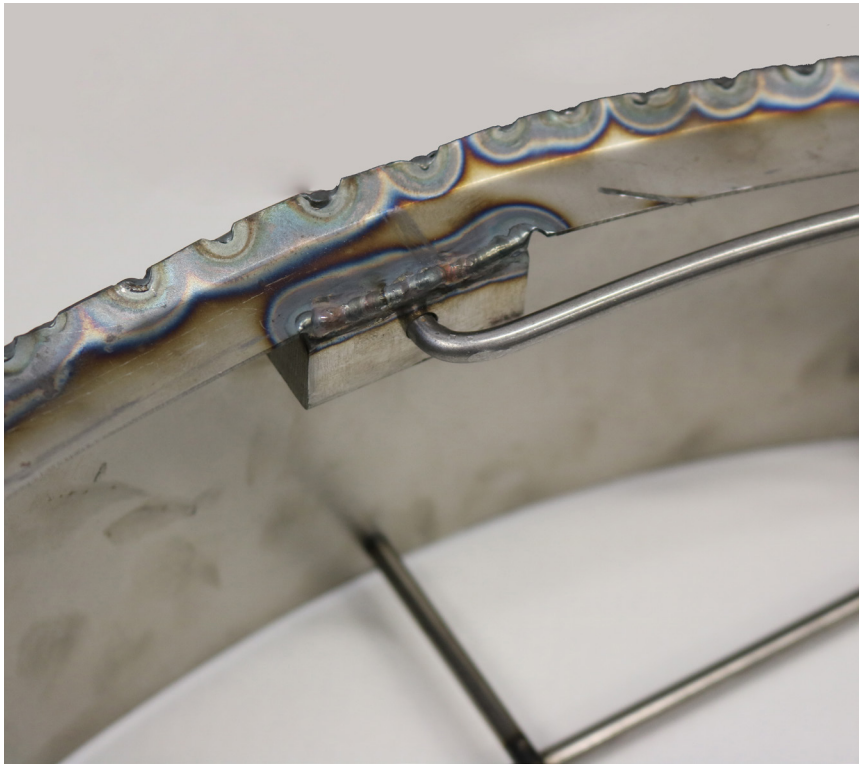
Finally, for the sake of completeness, a base was created to facilitate water collection. This base is not intended to be an integral part of the project from an aesthetic point of view, as it is up to the user to decide whether and how to use an improvised base, for example by placing it on bricks or wooden crates or architecturally pre-designed areas within the garden, depending on its needs.

Outside of the drum and rests of a cutted drum

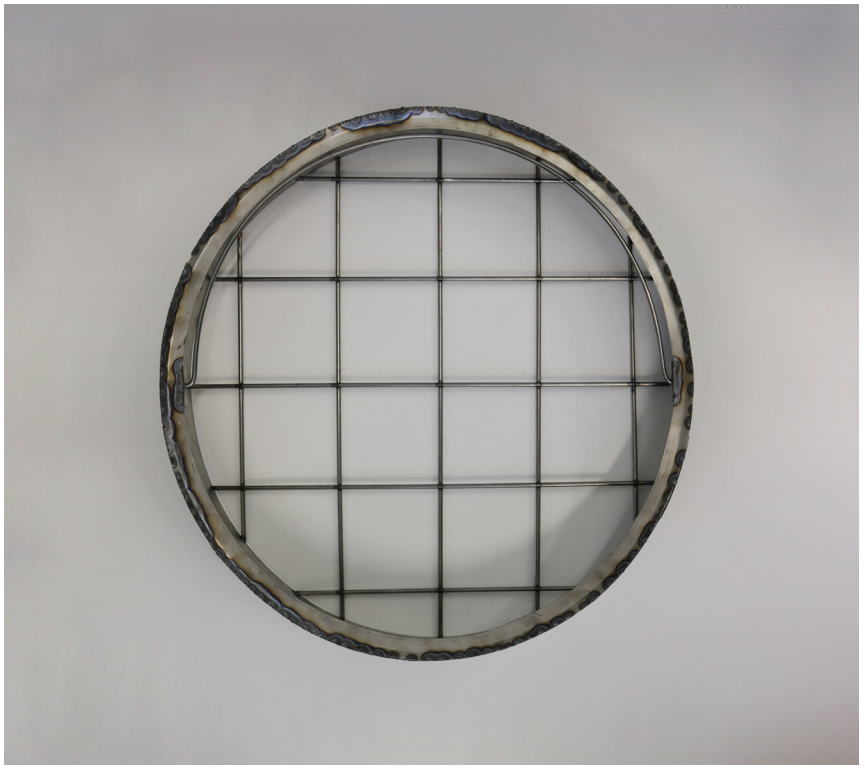
Interior of the drum during processing

Faucet for water extraction

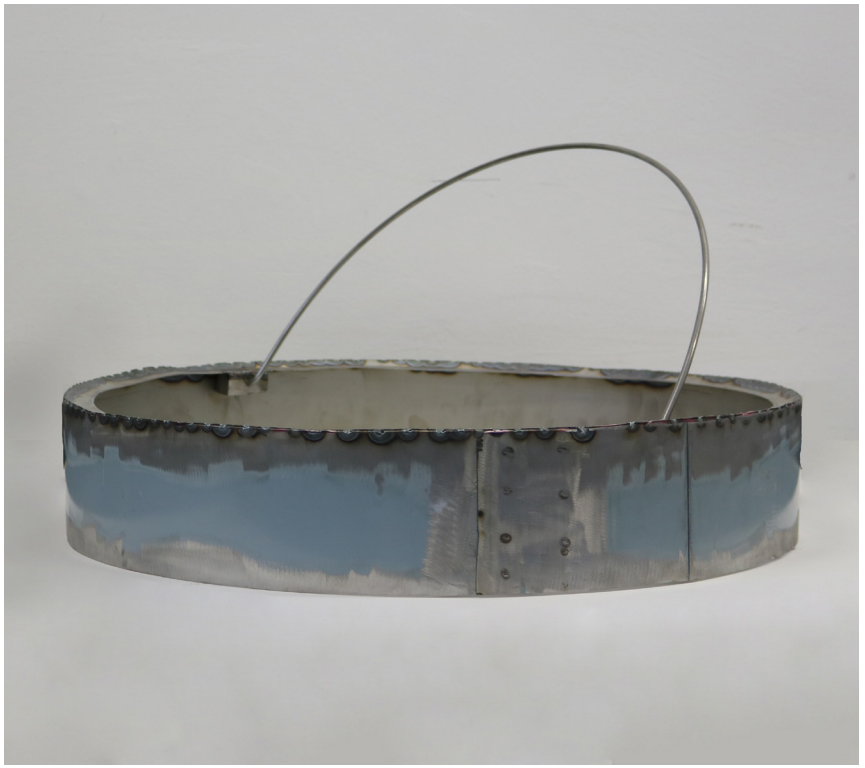
Electrowelded screws detail



Detail of handle insertion at initial stage



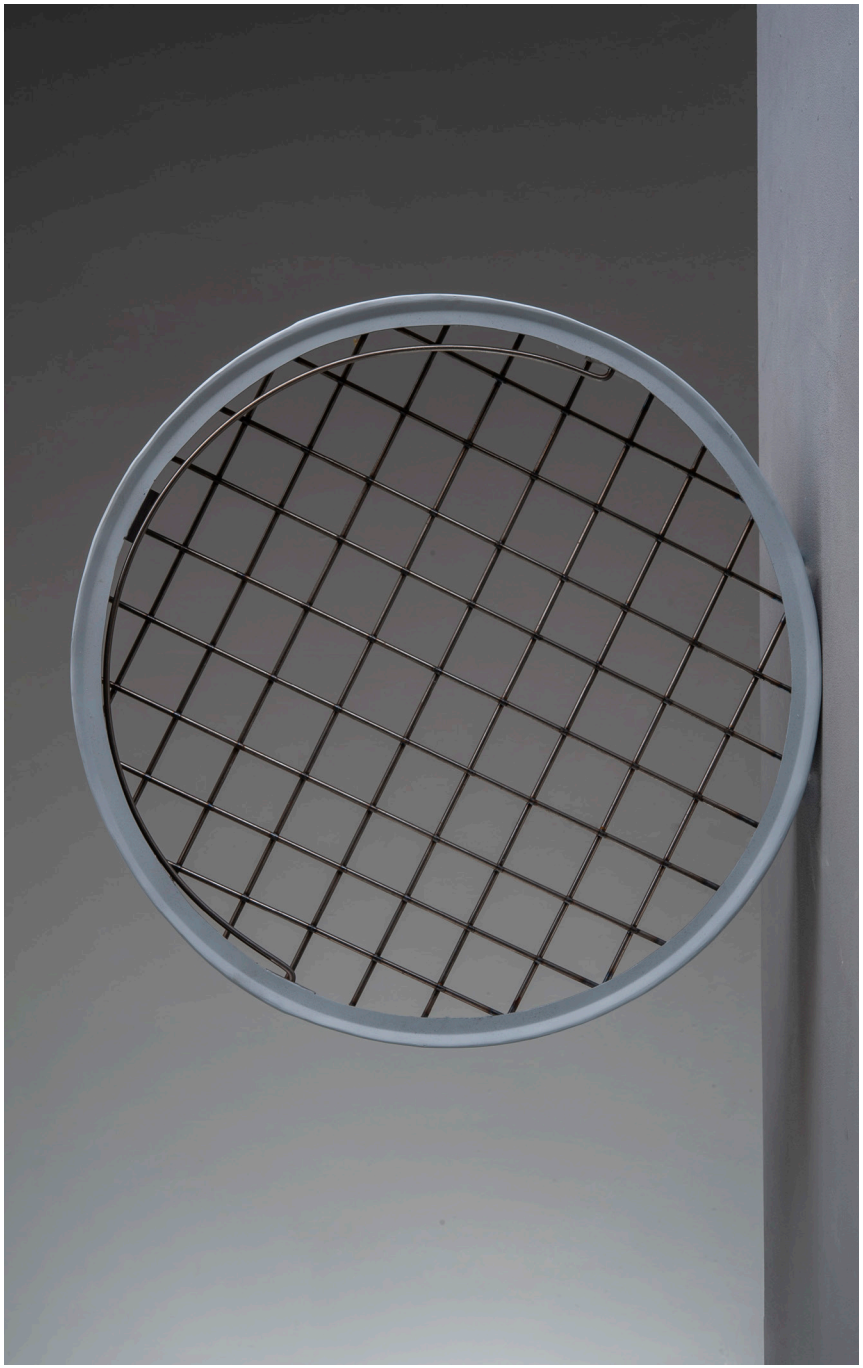
Top view of first welding spots

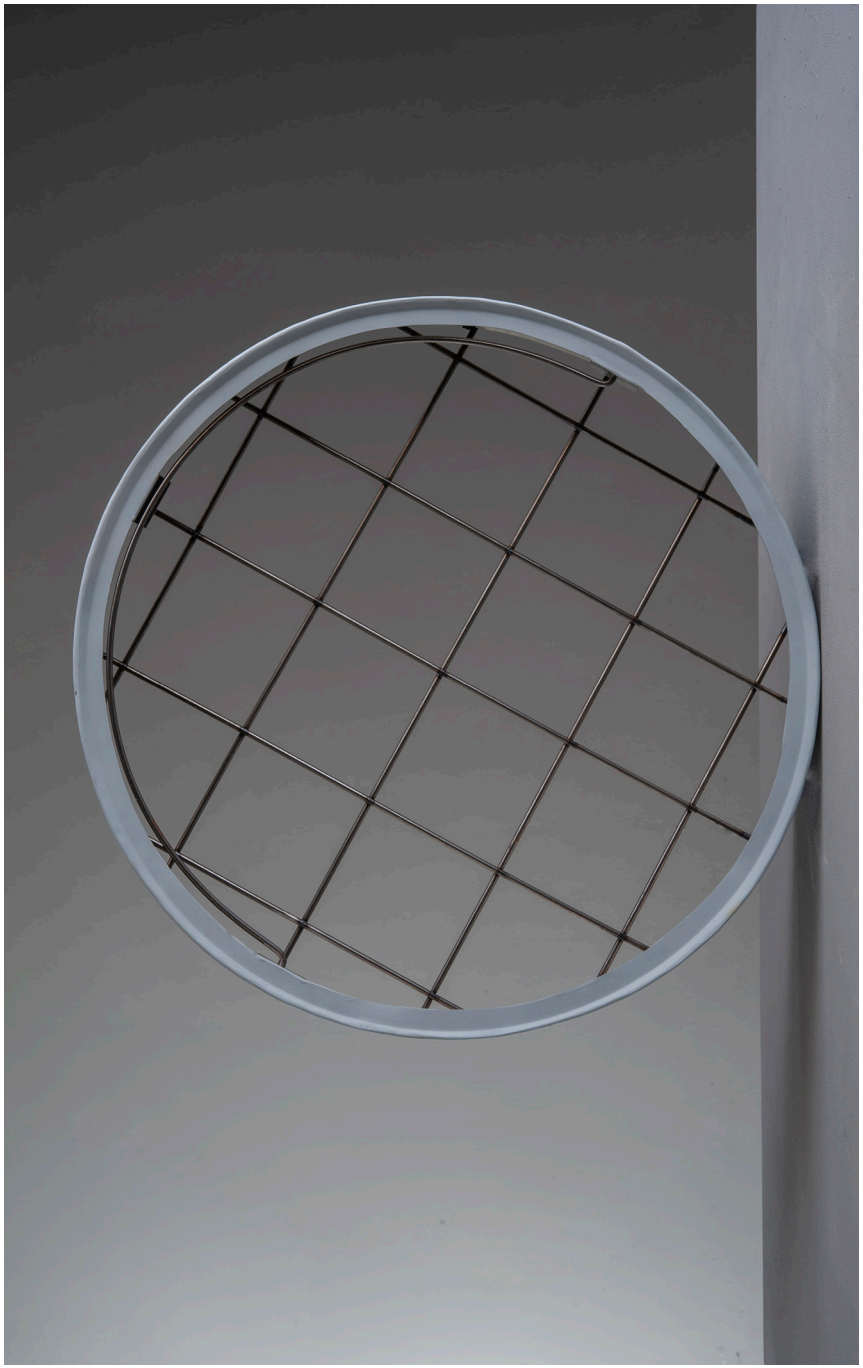


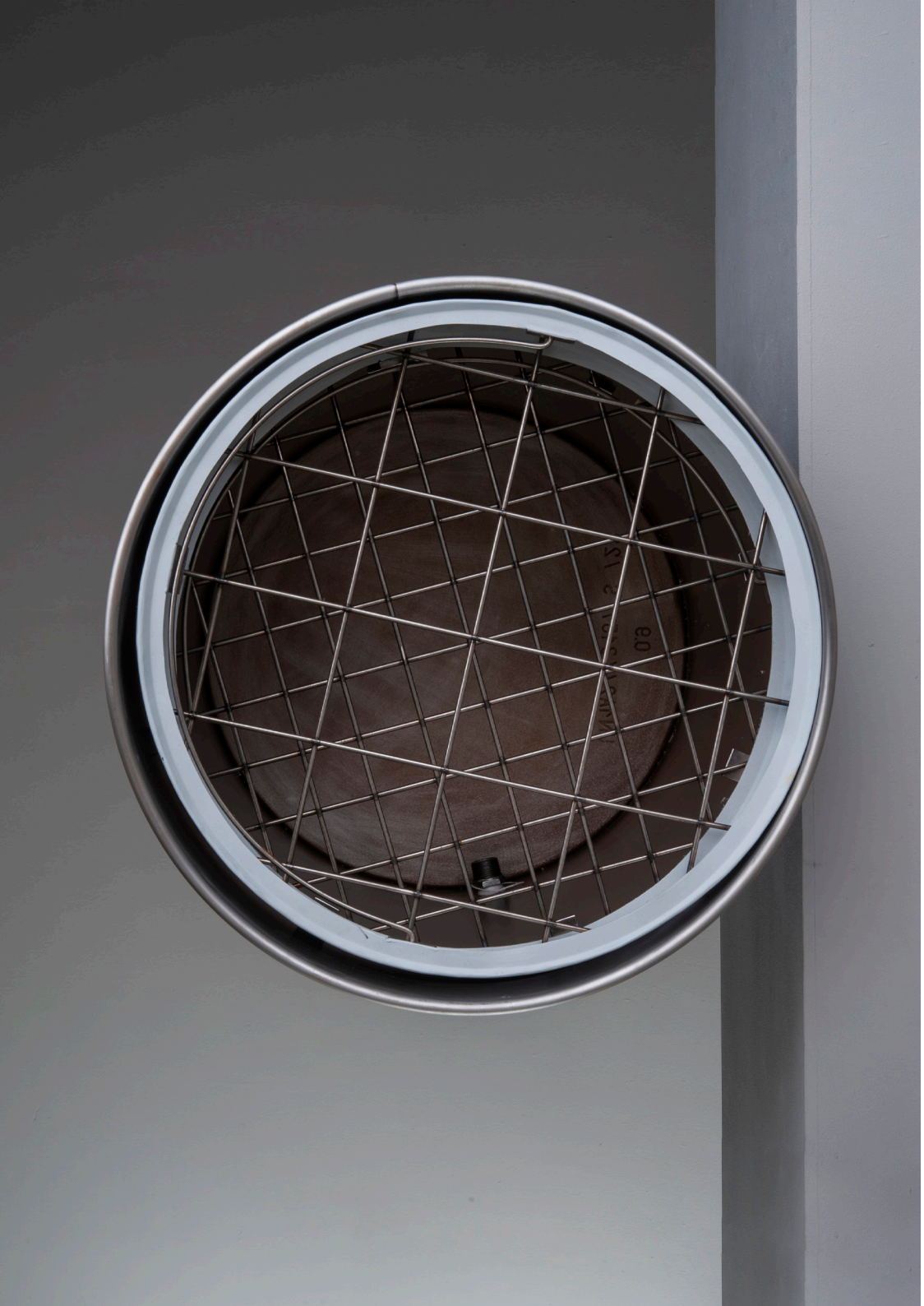
First tray after first welding

PROTOTYPE

The prototype is a representation as close to reality as possible, with a minimum margin for improvement. Following is a collection of photos of completed work.







THEORY

A documentation regarding the theories and languages of product design focalizing on different research carried on during the semester.

Initial research

Marble is a complex material. Research on it starts with an assessment of its possible sustainability. A material is defined as sustainable in the strict sense, generally when its use and extraction do not endanger its existence and regeneration. For example, wood extracted from trees can be replanted and potentially has no end. Marble, on the other hand, cannot be replanted and its creation process takes millions of years. Nevertheless, marble is impossible to exhaust. His presence on earth is incalculable by the human being. According to geology professor Stephen Marshak “Physically speaking, there is way more marble in existence on this planet than will ever, or could ever, be extracted, because the costs and economics of extraction increase beyond viability,” he adds. “In other words, ‘running out’ is an economic concept.” The difficulty in the extraction, causes an increase in the costs of extraction, which in turn increases the selling prices of the marble, which finally causes a decrease in the demand.

To define the sustainability of marble in a broad sense, it is necessary to take into account more factors than its capacity to generate itself and the use that man makes of it. To do this we need to know how it is extracted, how it is processed, and how it is sold.

There are mainly two types of quarries, the open pit, one of the most important examples in Italy is Carrara, and quarries excavated inside the mountains, an important example in Italy is Lasa.

The two types have very different impacts on the environment. Carrara, seen from satellite imagery, exposes “proudly” what can be called an environmental disaster, at least visually. Tons of rock ripped from the mountain as if they never existed. From above, an immense white surface contrasts with what remains of the vegetal nature of the Apuan Alps at the edges. The quarries that develop inside the mountain have a much smaller impact leaving the surface intact, if not for an opening where the quarry begins. Despite the smaller impact, it is not enough to define it as sustainable.

As regards extraction and processing methods, understood as human labour, techniques have evolved over time. As in any other field, the evolution has occurred due to an increase in demand and a need to increase the quantity while decreasing the time. Every type of mineral and material, in order to achieve a state of absolute sustainability, should be left unchanged and untouched. Like any type of material, marble is a source of profit for man and is consequently extracted. With this assumption, every extraction and processing technique undermines its sustainability, but today the consumer society that represents the earth’s population influences a more sustainable extraction and processing of marble in a negative way.

So how does the marble activity impact on terrestrial sustainability and with what consequences? The environmental impact is the most visible.

Visual impacts previously mentioned through the removal of rock from the mountain, as well as having visual consequences, cause the destruction of animal and plant habitats, through noise, water and soil pollution and soil vibrations. An important role is played by the marble dust coming from both the excavation and the processing activity. In addition to polluting water sources and air, it has been shown to cause floods by blocking or changing water flows. The “Marmettola” is the mud that is created on the bottom of the polluted water flows and that in the area of Carrara, for example, has created and continues to create problems due to poor waste management.

Furthermore, activities in the marble sector require a considerable amount of energy. Whether it is cutting blocks in the mountain or downstream slabs, the current used is of abundant quantities as well as the water used to cool such machinery. The transport of marble reflects another phenomenon of great consumption, being a material with an important weight. It is estimated that every 25 miles, the price for transporting a load of marble doubles.

The economy behind marble has been and continues to be violent, leaving no room for a type of circular economy that deals with the reuse of waste materials and optimization of every working process. Three quarters of a block of marble extracted from the mountain, during processing becomes waste, leaving room for the last quarter that represents the finished product.

Finally, the value of marble and its comparison with the value of other minerals can provide the last details to answer the question “is marble sustainable?”

Specific research

The value of marble is calculated through numerous factors. It depends mainly on economic, social and cultural factors. These factors are strongly linked, influencing each other. There is a white thread that links marble to contemporaneity starting from its history and its associated cultural heritage. Addressing this issue does not mean talking about the history of individual companies or facts that affect the local community of Carrara or Lasa, but rather putting marble on the timeline, making it clear that having white Carrara marble in your home or office means touching every day 2,000 years of history. Marble thus becomes an identity that represents the value of a territory, a people and a culture.

The society and culture of a certain place influence for example, the relationship that the population has with artifacts, which last over time, such as statues and fountains. Just think of how in the course of the centuries certain architectural styles differ depending on the region in which they are located, because of cultural differences, but also as depending on the social differences in the same place architecture can vary. In addition, society and culture are closely linked to industry, which has a strong economic influence. The user, therefore the population, indicates a trend or a necessity, that it must be respected from the supplier so as to make better circulate the economy. In the same way the supplier itself can dictate a trend or give an alternative, influencing the user's choice.

One example is shown by the Macael region in southern Spain. Very important for the activities related to marble, it showed significant changes in the relationship society, culture, economy. A region rich in marble has always exploited its resources, making the economy grow thanks to an abundant demand. But to show that the company changes and with it a certain trend, two companies have revolutionized the economy of Macael.

First Adoro, a Spanish company, which developed the "master plan for marble", transforming and improving the economy of the marble industry, after the global action plan of 1983. With this plan "exploitaition units" were created, organizing mines, deposits, industry and safety. This change arises from an awareness of a malignant and corrosive type of extraction, primarily by nature. Fundamental, for instance, the rearrangements in security controls and more important in the management of marble waste.

The company Cosentino, on the other hand, has revolutionized the region through the creation of synthetic marble that have overturned the market and reduced the excessive extraction of stone from the mountain. The pioneering products are "Silestone" and "Dekton". In this way, in addition to offering a greater quantity of products, with different choices, between aesthetic and functional qualities, they redefined the offer by changing the trend and demand of the region.

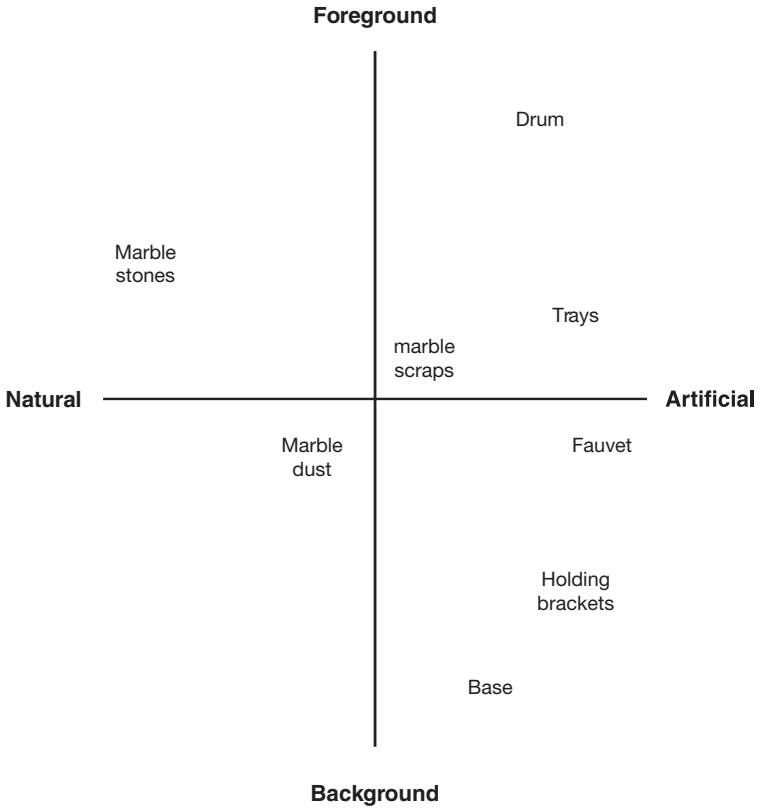
The goal was a product that:
1) maintained the characteristics of marble and natural stone in general.
2) was easy to handle
3) could be obtained at a lower cost.
4) could be produced in a variety of colours.

The study shows the long process that the marble industry has undertaken to improve its sustainable development.

Analysis in semiothic terms

Figurative trajectory:

The figurative analysis wants to express schematically how every object, part and material used in the product can be described using objective parameters. In order to do this it is taken in consideration in the diagram, the degree of importance or rather of visibility of a part. In the same way it expresses on another line the nature of the material of the object.



Plastic trajectory:

The plastic analysis has the role of explaining the object in its contrasts. This means analyzing the design of the product by contrasting the aesthetics and the perception of it, in colors, shapes, finishes, materials, functions.

Natural material / Artificial material
Exposed steel / Painted steel
Flat steel / Steel strips
Square base / Round drum
Exposed tray edges / Round defined drum edges
Exposed welding spots / Polished welds
Glossy paint (drum) / Matte paint (tray)
Shallow Tray / Tall drum
Industrial made screws / Hand made brackets

Interface trajectory:

The object shows a traditional type of interface. This indicates that the mode of use undertaken by the user is not hidden or explained directly. The faucet as the first example is the detail that catches the eye first when the barrel is seen from the outside. The tap indicates that a liquid is coming out of the container. The trays inside the barrel, although less clearly than the tap, explain to the user that they are containers for something, the nets of different matrices explain that the objects inside have different dimensions and the handle finally helps the extraction of the whole tray and its contents. The brackets inside the barrel may be the least explanatory especially when the product is disassembled. Finally, although the base is not part of the product in terms of design, it is absolutely necessary for the user, in order to extract the water from the drum. Without it, the space between the floor and the tap would be too short and would not allow the placement of a container.

Narrative trajectory:

This type of analysis aims at framing the values that the object can have. In the specific case of the product made the main value is to encourage the reduction of waste, through the reuse of marble, barrels and water.

Rethorical trajectory:

The rhetorical analysis of the project is certainly to direct the user to a reduction of waste. There are three categories of savings. The first concerns marble, now proven to be an ambiguous material from a sustainable point of view. The use of waste, dust and stones, avoids the use of materials that should be processed only for the filter role. Secondly, it counteracts water waste. Both for the reuse of rainwater, as well as the mineralization of water in such a way as to be used in smaller quantities, because of its improved qualities through marble. Finally, the construction of the drum and its internal containers also aims to deny waste, being made from waste materials and material from other drums.

Conclusion

The purpose of this project, besides designing, using the marble of Lasa, was to find solutions to problems so as not to create an apparently useless object. Counteracting the numerous moral and environmental problems that marble can represent has been the fulcrum, and it has been possible working with waste material and raw materials, such as remains and stones and dust, that can be collected both directly in the quarry and downstream in the processing areas.

But this project also targets the big issue of water, the protagonist of the last decades, in an attempt to eliminate waste and do as much as possible with the water we have available, for example rainwater, reused in an often unintelligent way. The user, whether private or public, has at his disposal an object that helps him to support these wastes and save the acquisition from water systems of drinking water not necessary for watering plantations.

To conclude, the realization of the product took place from recycled materials, being built entirely from barrels previously used for the preservation of ink and destined for landfill.

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