Dessau Department of Design
Anhalt University of Applied Sciences
Expertise II
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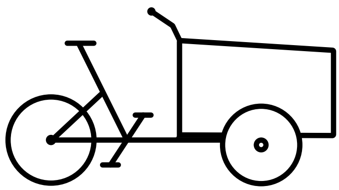
URBAN CARGO



BÄCHER BERGMANN
digitale manufaktur

MATERIABILITY
RESEARCH GROUP

URBAN CARGO

Urban Cargo

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Contents

Brief

The urban sphere is transforming. Automotive mobility is becoming visibly more autonomous and cleaner. Public transport has improved, expanded, and sometimes even the fare is free. Growing ecological awareness is turning roads into car-free-areas and entire city districts are restricted for vehicles with high pollutant emissions. At the same time completely new modes of mobility have emerged and as a consequence novel means of transportation are developing, but also new challenges in terms of their design and production.

The Cologne-based CNC carpentry Bächer Bergmann *(https://digital.productions)* manufactures transport boxes for various logistics and transportation companies using diverse types of bicycle-based vehicles. Yet, with the growing demand for sustainable, clean, reliable and fast urban delivery systems also the amount of necessary solutions grows. Food supply, the transportat of children, the removal of trash, juicers, who swap the batteries of e-scooters, taxis, and the delivery of post, packages and cargo – just to name a few – all require different approaches. Yet most existing products are mass-manufactured and therefore unable to meet specific requirements in terms of size, safety and adaptability. At the same time, whilst the transportation of the requested items is largely carbon neutral, the materials used in the making of these systems are often not. This poses another problem that in its very essence is incompatible with the ecological claim these companies stand for.

Task

Together with Bächer Bergmann we wanted to come up with innovative designs for transporation containers, develop customizable processes for robotic or similar digital manufacturing methods, and find materials that meet the necessary requirements. The containers should be:

- extremely lightweight and durable
- (if possible) fit the size of an euro-pallet (80 x 120 cm)
- water and weather resistant
- shock resistant, durable and easy to repair
- biodegradable, sustainable or recyclable

Bio-Composites

Willy Axt

Bio Resins

Natural Fibres

Composites

Material Research

Looking through studies on lightweight yet durable materials for the transportation sector offers one a plethora of useful choices. However, when it comes to delivering performance while also considering environmental factors, options like natural fibres and bio-resins become a viable option. These fiberglass-like materials offer very similar mechanical properties, an interesting look, and the very same manufacturing techniques, making bio-composites a serious option to consider in the construction of lightweight body panels.

Literary resources like the book 'Lightweight and Sustainable Materials for Automotive Applications' present a more detailed description of what current thermosets offer. The book compares several common practices in the automotive industries with environmentally friendly alternatives. These alternatives do not necessarily mean that the material is recyclable. It can mean that it is sourced from natural resources. Given the parameters of the project, taking the step of using naturally sourced materials is still the right one. Automotive parts should be designed for long term use, bio-degradable materials would only quicken material fatigue. At the time of researching this project, it was not possible to find an answer to the question of recyclable composites made from biobased materials.

Bio-Composites

Fibre Mats

Bio composites make use of natural fibre resources and bio-based resins. Thermo-sets like 'Expoxy Resin' are derived from diglycidyl ether (DGEBA). The so-called DGEBA can be replaced with 'Bio-based DGEBA' which can be derived from non-petrochemical sources. This bio-resin is chemically identical to the one sourced from petrochemicals.

Fibres

Natural fibre sources are plenty and are already heavily in use as wood-pulp takes a very long time to produce and recover. Alternative fibres include wheat-straw, rye-straw, sisal, and hemp. The properties of the final composite is largely defined by the fibre-source. These must be carefully picked as seasonal changed can have an effect on crops and thus the fibres. Studies have shown that fiber-glass-like performance can be achieved using hemp or sisal fibre. An interesting factor may be the locality or general availability of the fibre. Using these types of resources can lead to cost savings as agriculture waste is rather cheap to purchase. Or it can be a growth factor new agricultural businesses.

Sisal Fibre

Wood Composite

Fibre Quality

Mould-Shaped

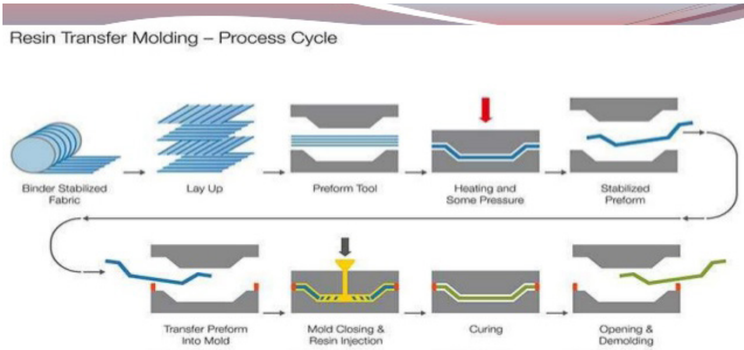
Tinted Resins

Resin Transfer Moulding (RTM)

Construction & Assembly

Construction with bio-composites use the very same techniques as fiberglass, or carbonified manufacturing. Common methods include simple layering of the fibre in strengthening patters and brushing resin on top, to using advances and well-tried methods like 'Resin Transfer Molding' (RTM).

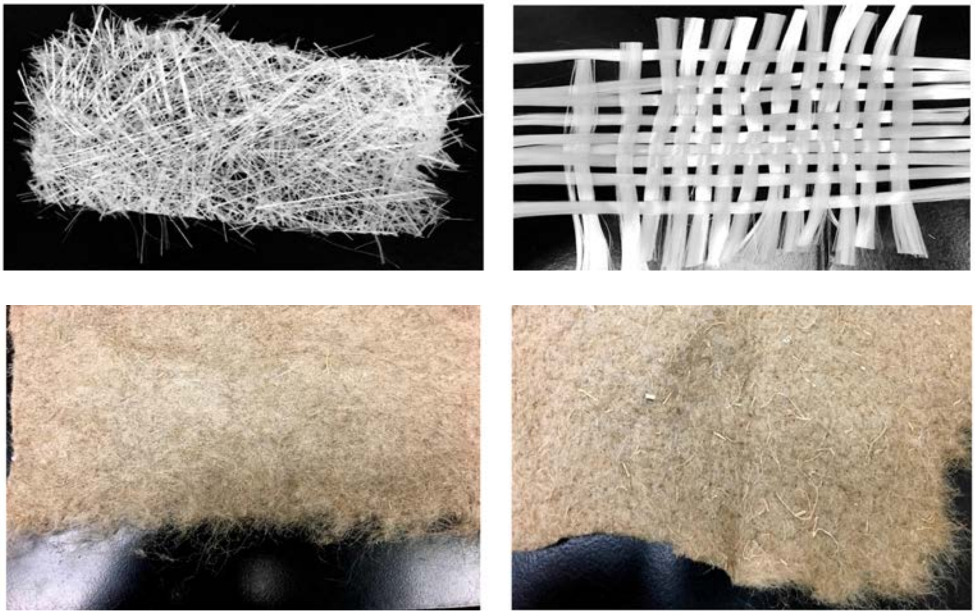
The most efficient option depends of course on the requirements of the project at hand. May it be a factor of usability, engineering, or the number of units being produced. Fiberglass manufacturing techniques allow for very high versatility as almost everything is done by hand. The result can be brought to very high surface standards, as this material is used in the production of cars and yachts.



ENTROPY RESINS.

Table 5. Mechanical properties of (untreated) hemp fiber reinforced unsaturated polyester composites

Fiber	Fiber wt/vol fraction (%)	Tensile Strength (MPa)	Tensile Modulus (GPa)	Flexural Strength (MPa)	Flexural Modulus (GPa)	Impact Strength (kJ/m^2)	Reference
Hemp	35 (vol)	60.2	1.74	112.9	6.40	14.2	[50]
Hemp	36 (vol)	–	–	110.0	7.50	13.0	[45]
Hemp	30 (vol)	38.0	6.0	100.0	6.50	20 (J/m^2)	[53]
Hemp	20 (vol)	33.0	1.42	54.0	5.00	4.8	[54]
Glass (CSM)	7 (vol)	–	–	108.0	5.60	34	[45]
Glass (CSM)	20 (vol)	73.4	7.9	233.8	9.28	80.4	[55]



RTM offers a wide array of possibilities in terms of freedom of form, the overall quality of the construction, and the production costs. Using CNC-milled, or even hand-crafted molding tools you can produce parts with consistent wall-thickness. The injection molding type production of closing tool halves to inject a liquid (or semi-solid; see thixotropy) makes the process very linear and easy to implement. Essentially a weave or other type of fibre matt would be layered appropriately to statical requirements into the mold. By closing the mold with the opposite half, the fibres are held firm into the desired shape. Using pressure and vacuum you can now fill the remaining air pockets with an injection of resin. The setting of the thermoset is either achieved under temperature or through time. The parts can be removed and are immediately usable. It is also a possibly to mold parts like threading for screws, or guide rails, straight into the part.

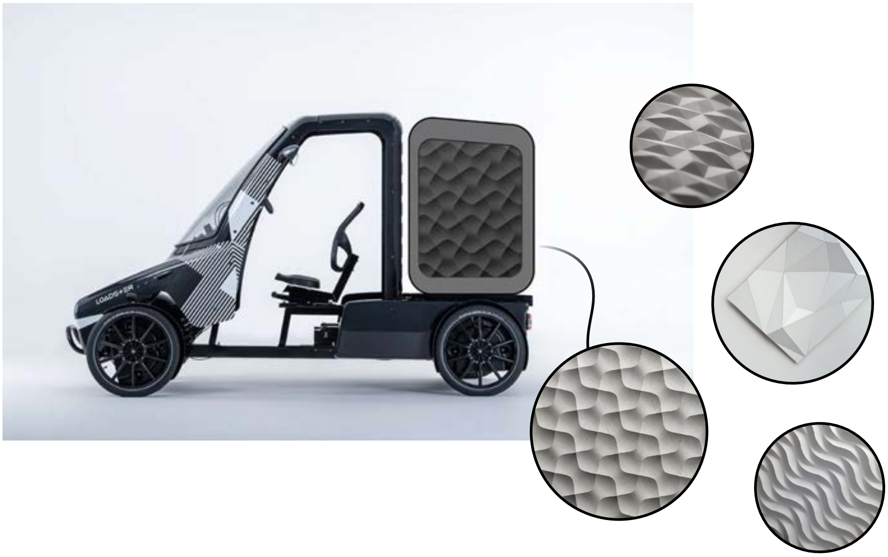
Simplistic

Dynamic

Edged

Design

Inspiration for the design was not only taken from the unique look of unfinished bio-composites, but also from simple form elements. This project can be home to any formal thought, so a humble assortment of variety was chosen to present. These where worked out in part of a process. Some of the formal elements used here are simplistic shapes, dynamic creases, and angled or edged surfaces.

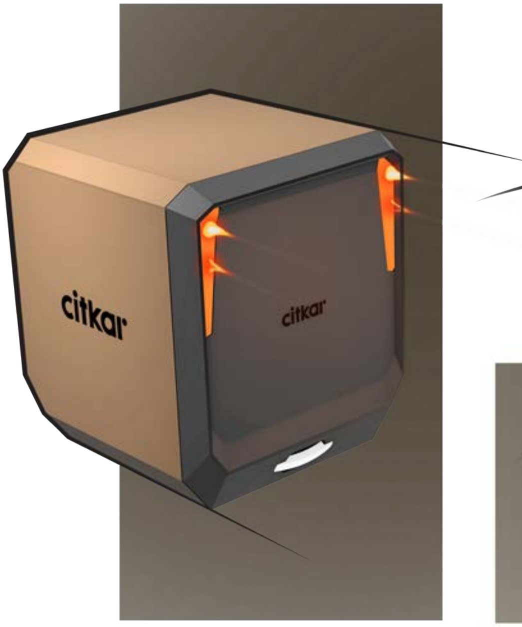



citkar
asif graphy

Basic shape studies

There are many possibilities with bio-composites when it comes to shape. As the tools can be removed by hand it makes the options of undercuts or interchange-able tool halves much more accessible. Using basic shape studies, like 2D profile sketches makes can be a way to start of the search for shapes.

Parametric patterns or even embossed logos can add interesting detail to the design. They can also structurally hold a flat surface. This can also be done via creasing. This practice is common in the transportation sector, it combines well with dynamic shape flows.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Loading space caused by door movement

Using some of the 2D sketches these 3D studies test out final shapes for the design. Each concept can be tried for functionality or manufacturing afterwards. Sometimes only small changes are needed to implement a design. This method is useful for quickly generating creative variants while also filtering out designs which translate bad into the later process.

#1

#2

3D-Form studies

These renderings show that the material achieves the desired effect. Here, the overall impression of the concept can be assessed.


#4
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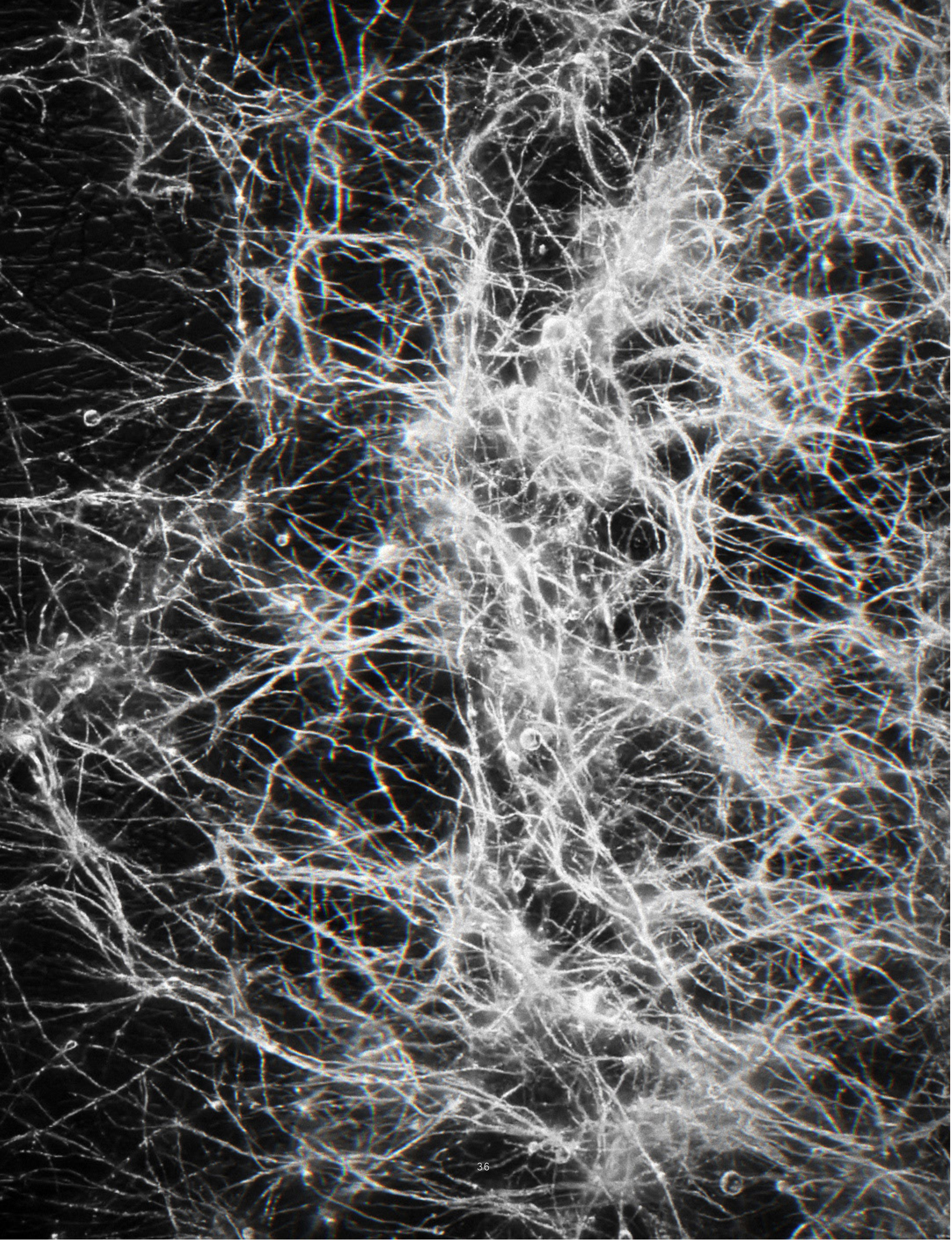
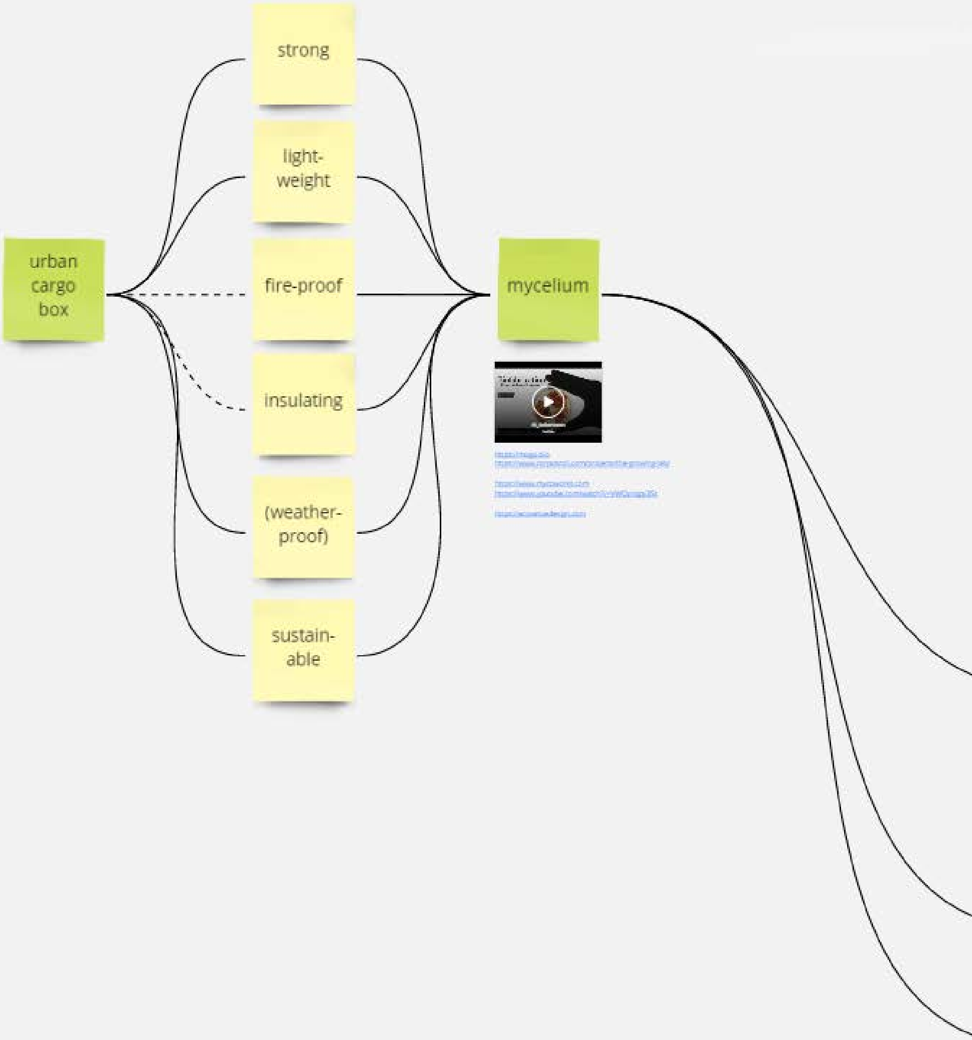
Mycelium
Cargo Box

Karl Richard Breitling



Material Research

When you think of mushrooms, you usually only have the fruiting body in mind. But most of the fungus is underground and is called mycelium. This is the vegetative part of a mushroom. It runs through its surroundings like thin threads. These can be seen as a white network, but can also be microscopic. This network can occupy very large areas. In fact, the largest living thing on Earth is a mushroom in Malheur National Forest, Oregon measuring 9 square kilometers and 600 tons. But it‘s not just their size that‘s impressive. They are also among the largest recyclers. By converting dead biomass into their own, they return it to the food cycle. In this process the mycelium take the nutrients from the substrate to grow and binds the loose material. This can be used to create a solid composite material. The quality of the material depends on the ingredients, the growing condition and the post processions. The main shape is created by a mold in which the mycelium grows. Different companies experiment with mycelium for their Products. For example Ecovative Design started developing mycelium alternatives to polystyrene and plastic packaging in 2007. But mycelium is also used for furniture, bricks and leather.



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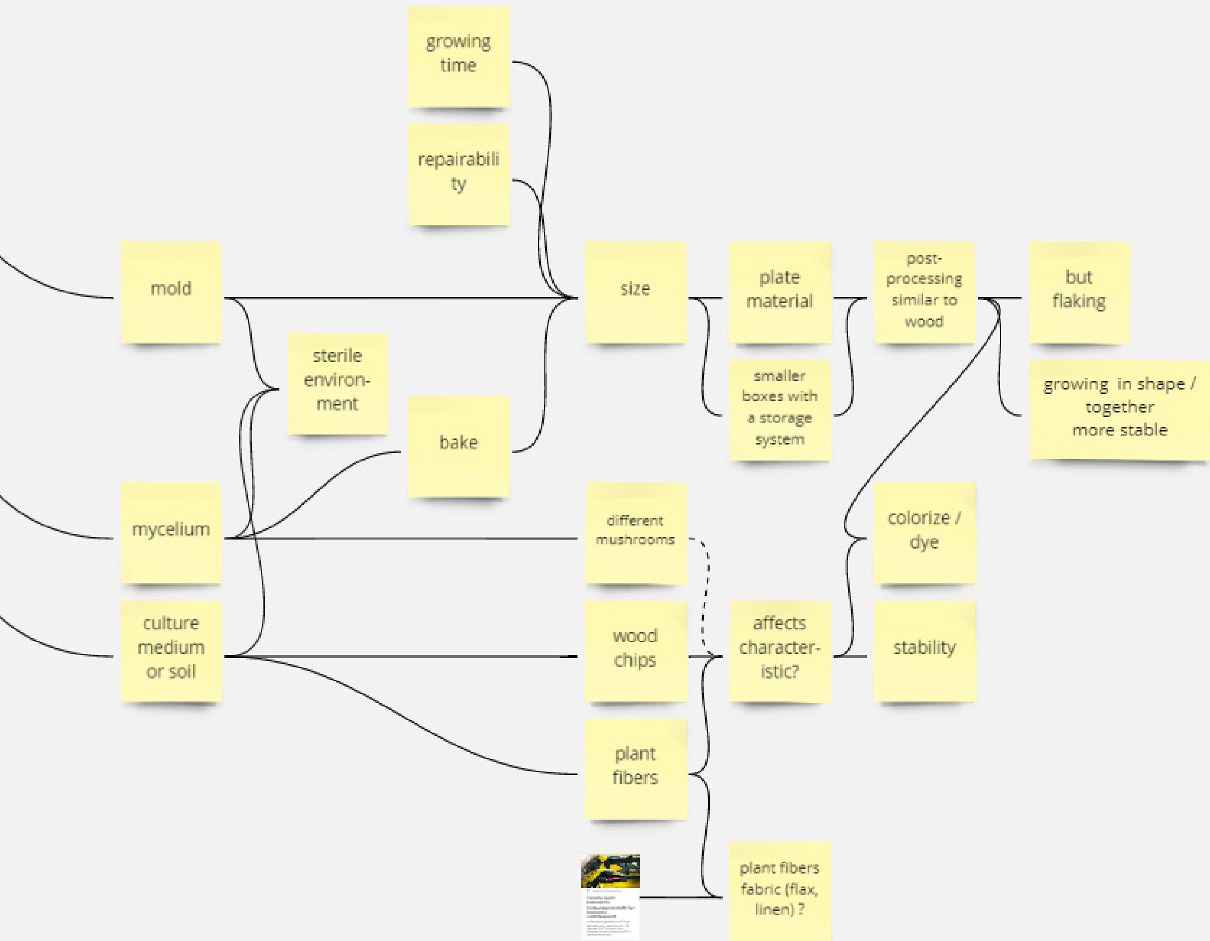
Construction & Assembly



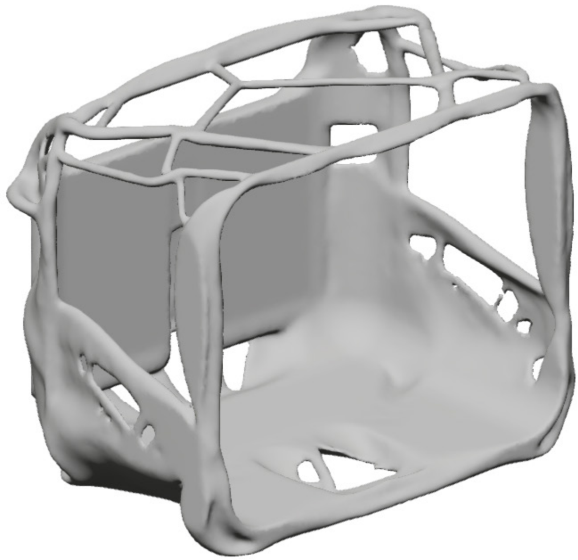
Design I

Design II

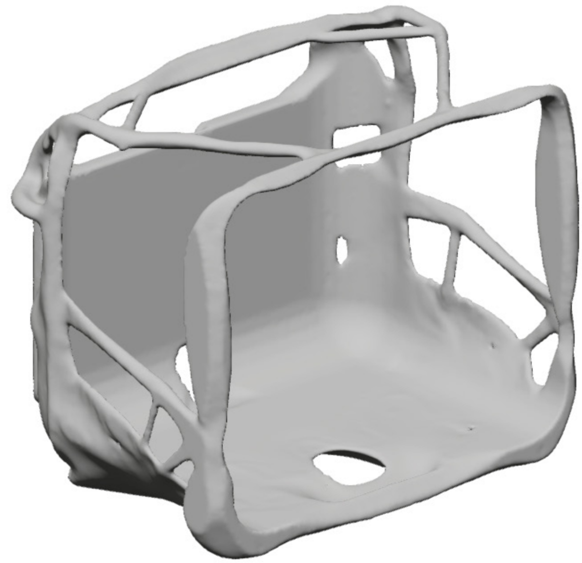
Design

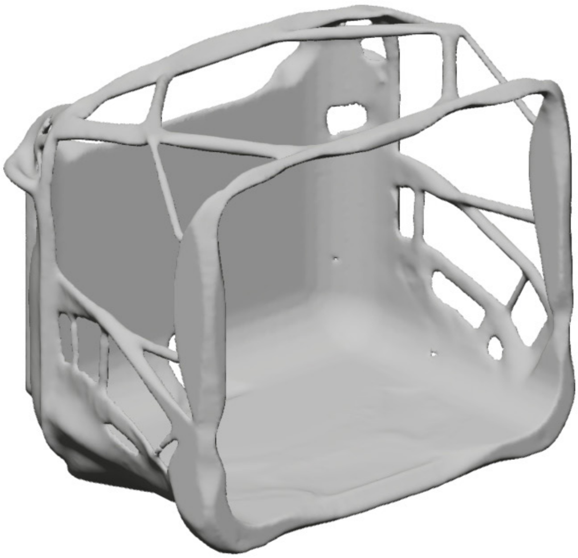
To give the box a form I followed two design approaches. Design I is based on the Fusion 360 generative design algorithm, which generates a lightweight but highly stable skeleton structure from a basic geometry and structural loads. The main focus of this box is to hold the transported goods together. Since most of them are already packed in such a way that they are safe and protected from environmental influences. For example, food delivery services or local farmers who bring their products to market. In addition to the efficient ratio of material and stability, the organic aesthetics shows a connection and responsibility to nature.

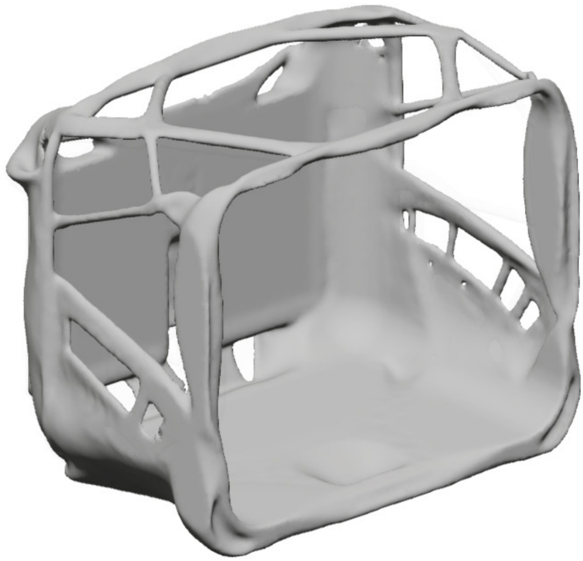
Design II focuses more on the story of the mycelium material. It uses the natural root structure of the mycelium which is parametrically distributed over the box to show it clearly. Together with the unique surface, an aesthetic is created that shows mycelium as a new, sustainable material.

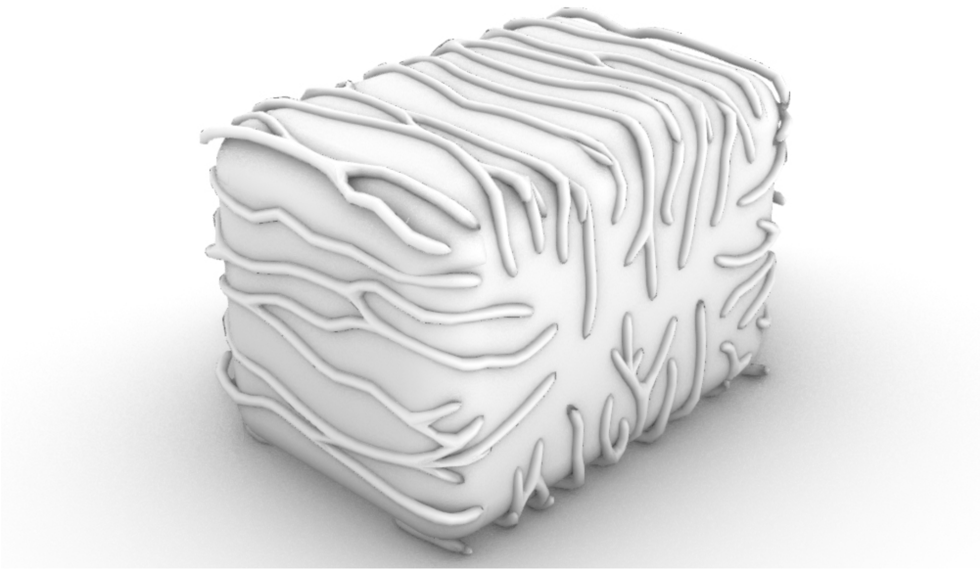


Design I: A couple of design studies with different loads.

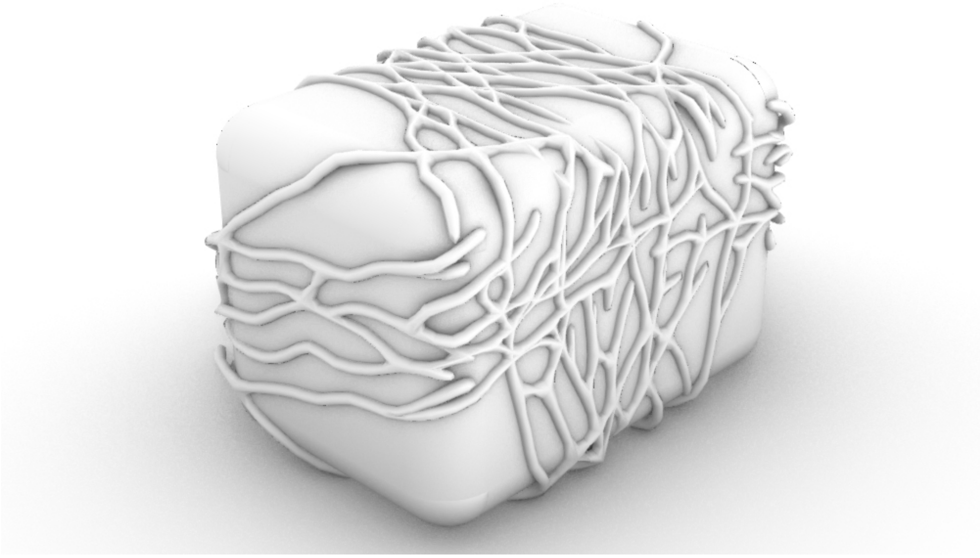


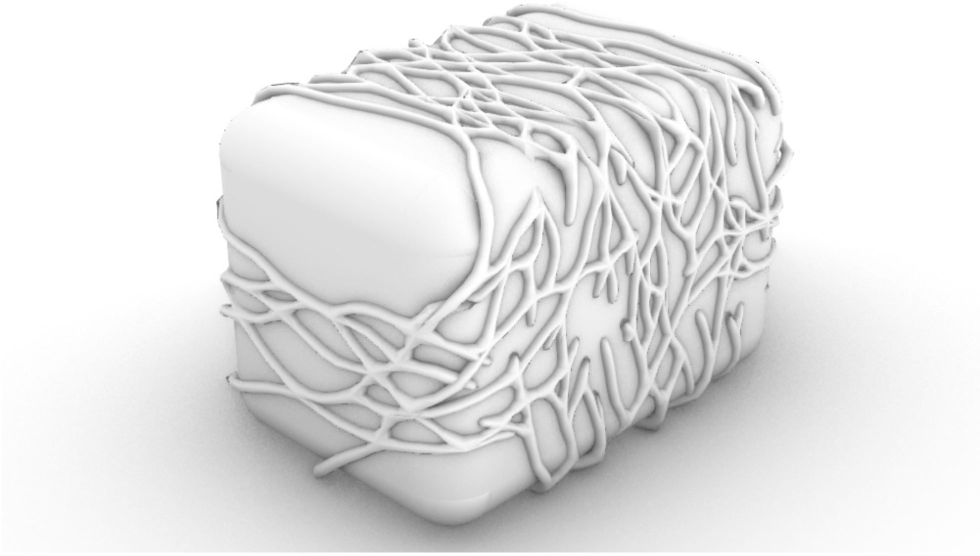


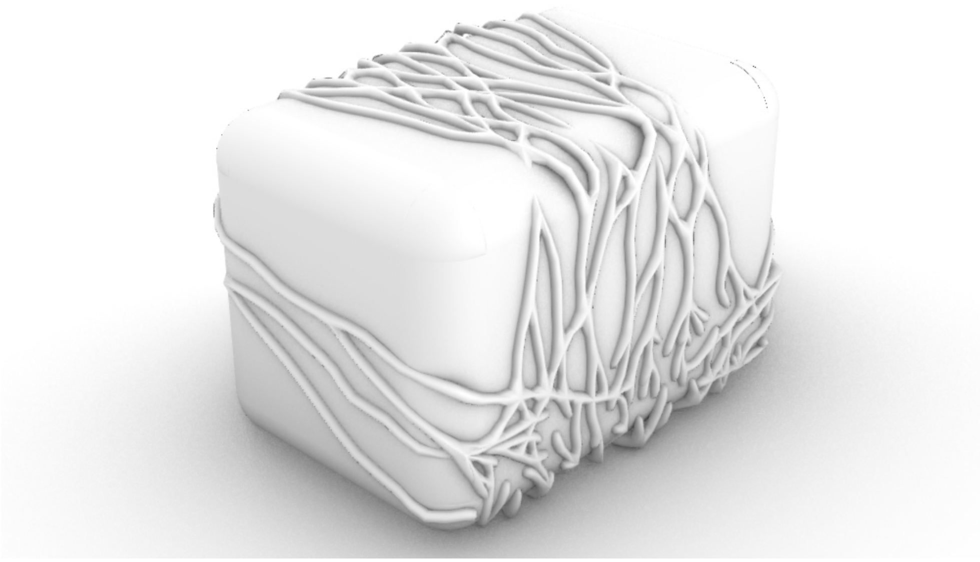




Design II: Variations of different root structures on the box.



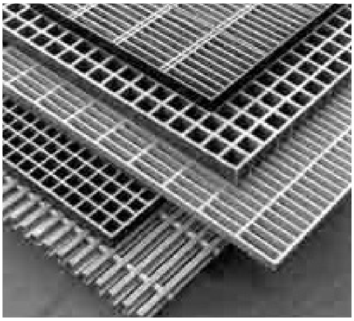




Straw Board Container

Judy Elkhatib

Fibre Reinforced Plastic



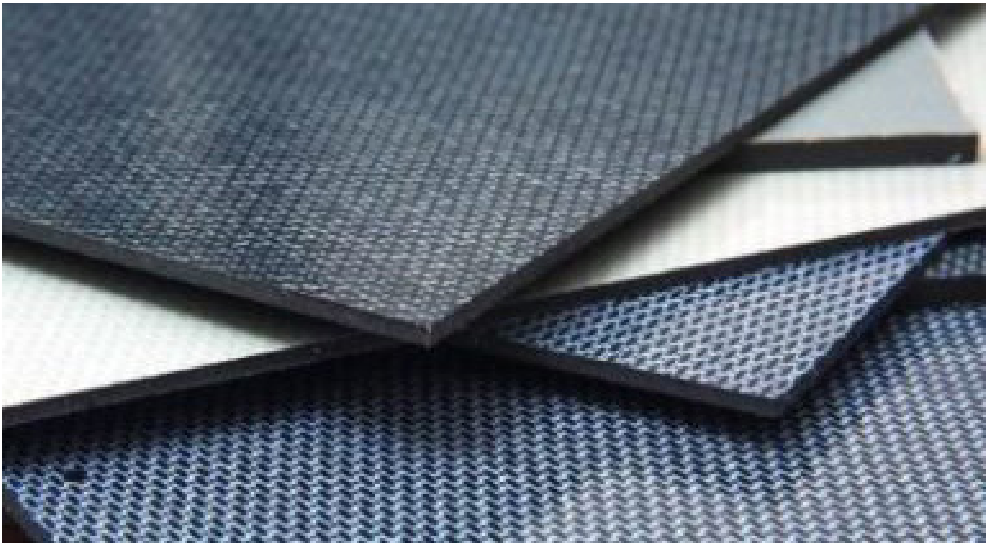
Polyethylene

Compressed Straw Board

Material Research

This project started with vigorous research on materials that meet the requirements needed to design an innovative transportation container, to be produced by Bacher Bergmann and mounted onto Citkar‘s Loadster. This container needed to support the ecological claims that the mentioned companies stand for, similar to the mostly carbon neutral transportation process provided by the loadster. Key features of the required material were lightweightedness, durability, weather and shock resistance, water resistance, ease of repair when necessary, and finally, biodegradability, sustainability or recyclability.

Fibre Reinforced Plastic



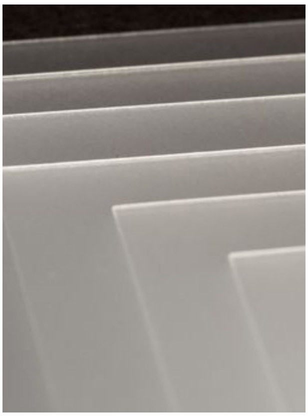
Glass fibre reinforced plastic sheets (FRP)

Fibre Reinforced Plastic (FRP) is a composite material made up of a polymer matrix reinforced with variable fibres such as glass, carbon, and sometimes wood fibres. This material is best suited for applications which require weight saving, strength and durability, and a reduction in the number of parts during production and operation. This also makes it cheaper, easier, and faster to produce in comparison to aluminium or other metals which have similar strength and properties. However, similar to the most widely used plastics, FRP comes with disposal and recycling concerns. Disposal by applying intense heat is known to be bad for the environment and it is difficult to separate FRP back into its base materials for recycling and reuse.

Polyethylene

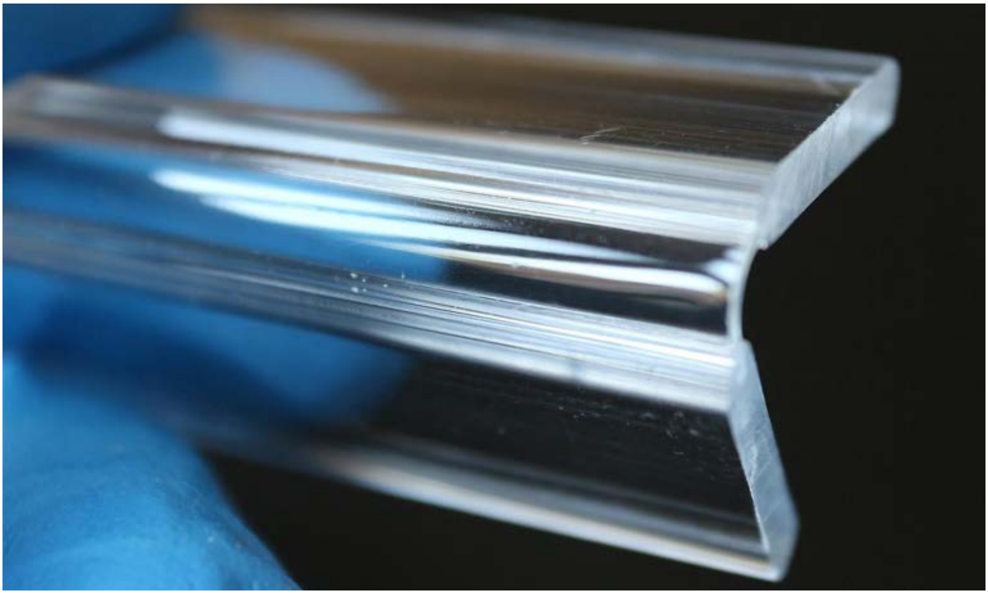
Polyethylene (PE) is one of the most widely used and produced plastics. It is a lightweight and durable plastic polymer that has been used in many applications ranging from consumer goods and textiles to packaging and automotive industries. PE can be processed by injection molding, extrusion, blow molding, and rotomolding. PE also comes in a wide range of densities to serve specific purposes accordingly and is very well suited for extreme cold or hot weather conditions. Aesthetically speaking, PE can be produced in different colors, and can range between clear, milky-opaque and opaque. However, fumes produced during the manufacturing process of polyethylene can be toxic, and it is not generally a biodegradable material but it is rather recycled and reused for different products.

Clear PE sheets



PE water pipes

Colored PE storage box



PE clear living hinge

Aside from the cargo container itself, PE can be used for the making of what is known as a 'Living Hinge' which is a singular piece with an hourglass cross-section, strengthening its hinging mechanism. Unlike metal hinges, the advantages of living hinges made of PE is lighter weight, better design aesthetic, can be 3D printed in-house, made in a single part which makes production easier and less costly. Additionally, by being a plastic, this living hinge resists rusting and corrosion, carries the same strength as aluminium hinges, and is water and weather resistant. Opening patterns for conventional fasteners can be easily customized on the hinge flaps or the hinges can be attached using a strong adhesive.

Compressed Straw Board

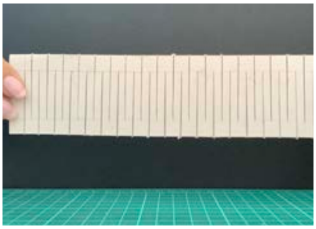
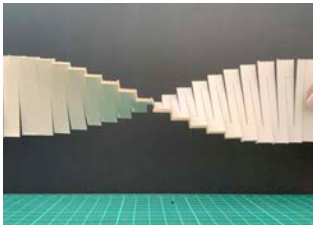
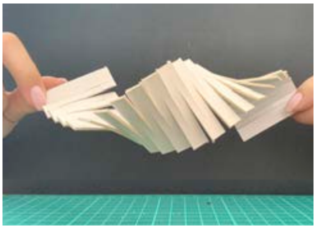
Agricultural waste left over after harvest is usually disposed of by burning. Compressed straw board is a material composed of 100 % agricultural waste such as wheat, rice, or barley straw. After finely cutting the straw, it is compressed under high temperatures which activates the naturally present lignin in straw and acts as the binding agent, forming strong compressed straw boards. The result is a board far more superior than MDF. Straw board is made from an annually produced inexpensive source, it has a high strength to weight ratio and a higher resistace to warping, water and fire in comparison to regular wood panels. Additionally its load bearing capacity and acoustic properties makes it a popular material in construction.

Wheat-based straw board

compressed board in cardboard paper

close up on straw grain

Test I

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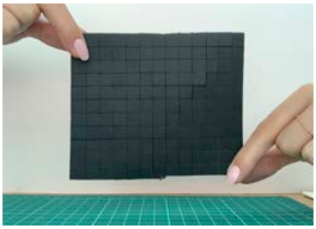
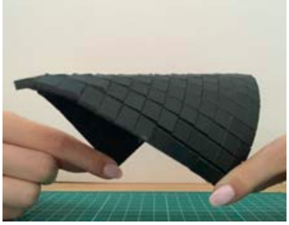
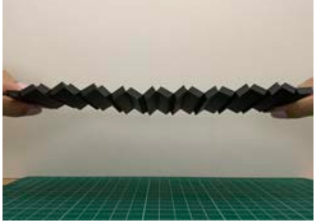
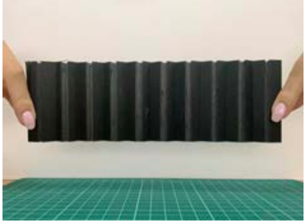
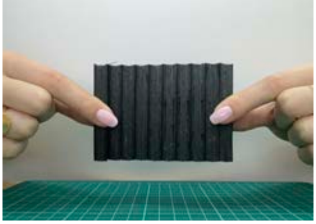




Test III

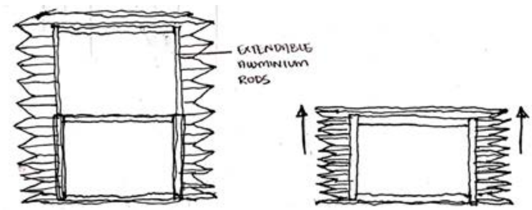




Construction & Assembly

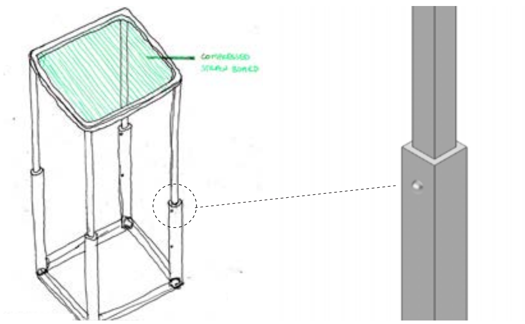
Applying steam to wood might be the most common practise for wood bending. However, for plywood or particle boards, steaming is not as successful as kerfing. Kerf cut lines are made in wood to create bending, stretching, and warping. This allows solid materials to go beyond their physical characteristics and exhibit textile properties. In the case of using compressed straw board as the main material for the container, which is compared to particle boards in composition, I tested out different kerfing techniques to see how far beyond its limits can the material be pushed and how that can inform the shape of my container.

In the tests above, the main variables were kerf depth, spacing, angle and pattern. In Test I, straight alternating cuts that go through the material result in a two-dimensional and multidi-mensional twisting movement, smaller radius and smoother bending. In Test II, kerfs in the x- and y-axis at equal intervals allow a high level of flexibility to the surface, almost imitating textiles. Bending in one direction only is possible since the attempt to bend in the opposite direction as well weakened the material and caused breakage. As for Test III, creating kerfs on alternating faces, not going through the material, at equal intervals result in an accordion-type movement with a stretching and compressing opportunity.

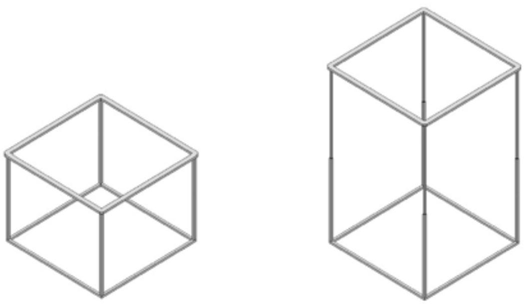
Sketch I



Sketch II



Sketch III



Sketch I shows how I intended to apply the kerfing technique to the compressed straw board for the container box. Since the material is now flexible and movable, it requires an internal structure both for support and dictating the movement. An aluminium frame with four telescopic extendable rods is used, the rods could be ajdustable to several heights (Sketch II).

The kerfs in the straw boards can be made using a CNC mill, a saw blade, or a laser cutter for accuracy. The retractable panels of compressed straw board are attached to the top and bottom of the aluminium frame and follow its up and down height varying movement.

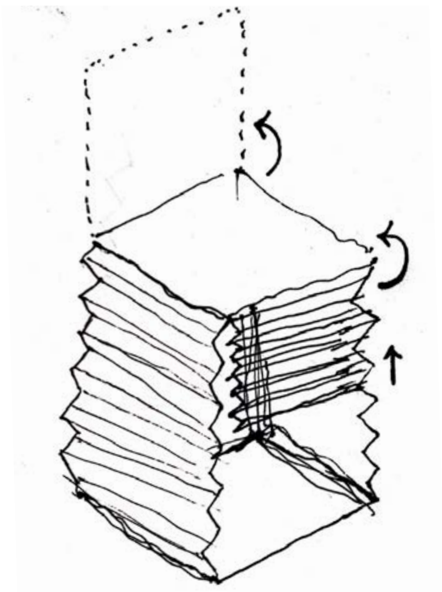
Reference I

Reference II

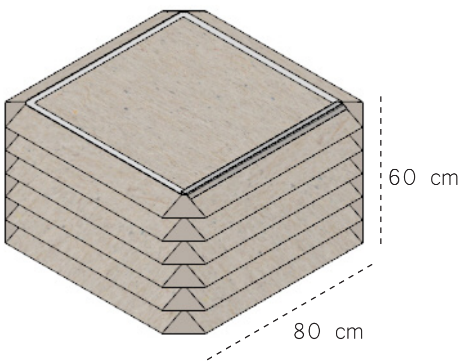
Design

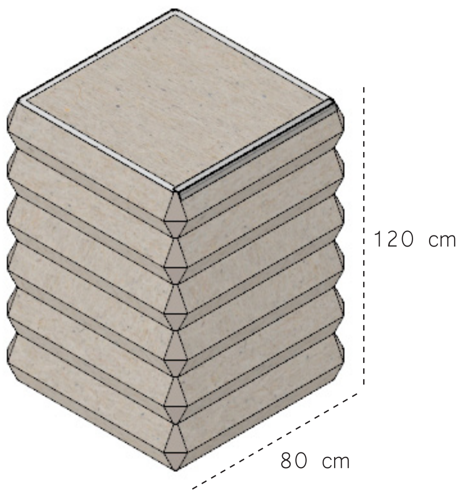
In the reference above, the operability of the accordion movement has been used as an opportunity to conceal an inner storage shelf in a playful manner, while maintaining the overall size and shape of the object.

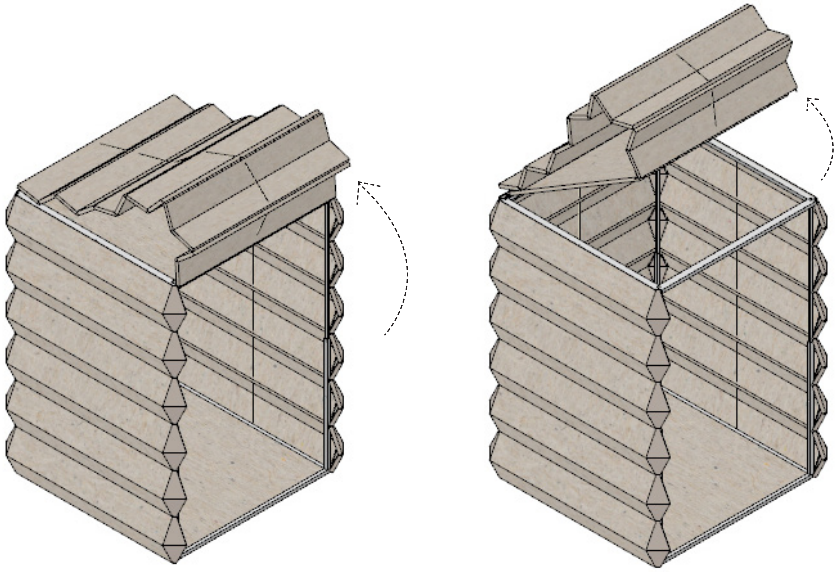
By taking advantage of the retractability, I attempted to design the container in a way to indicate the capacity of the box without opening it. This can give the transportation vehicle a lighter overall look and an indication of whether the delivery process is at its start (maximum height) or approaching the end of deliveries for the day (minimum height).



Operability study







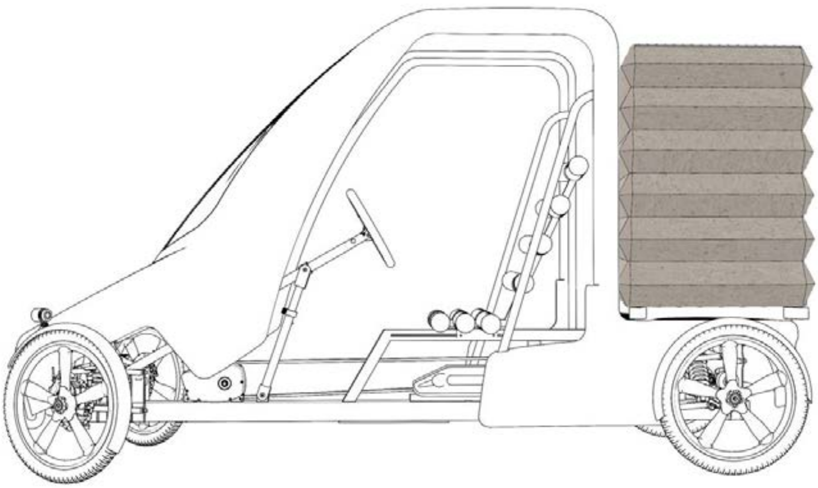
Double operability

The container can range between a minimum of 60cm and a maximum of 120 cm. The four sides of the straw board panels are held together using additional kerfed corner pieces, while a thin fabric rope, similar to the ropes of blinds, goes through each panel to prevent the panels from curving inwards or outwards during the stretching or compressing of the container.

The 'door' panel of the container operates like a fabric door which can be unlatched and folded up into whatever shape it curves into. The top straw board panel can also be further opened if necessary. Both the kerfed straw board and the operable top board are connected using a clear polyethylene living hinge.


LOADSTER


LOADSTER



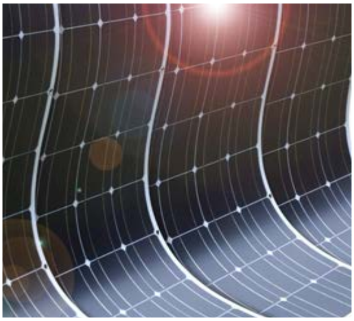
The exterior of the compressed straw board container can be left untreated and in its natural color and texture as a way of boldly stating the sustainability aspect of the container and transportation vehicle alike. However, since it is also a very versatile material, graphic design, visual marketing and ads can be easily placed on the surfaces created by the kerfed panels. The compressing and stretching can also be used as an opportunity for playful ads and marketing.

Triangulated Solar Panels

Mallika Manchanda

AuREUS

Solar Panels



Mycoboard

Material Research

The most important criteria for the material were that it should be lightweight, weatherproof, sustainable and durable. I started off the material research by researching Mycelium, a material grown from mushrooms. It fit all the criteria, however, its production process is slow. While researching mycelium-based textiles, I came accross solar based textiles which are smart textiles that can be used to generate solar energy as they are embedded with photovoltaic cells. I then realized a design opportunity for the boxes and cargo bikes. Since they have a large surface area which is constantly exposed to sunlight, this could be a good opportunity to incorporate solar panels. This could not just power the vehicle or a temperature controlled box, but also to make a statement and send a message about the sustainable nature of these cargo bikes as a last mile delivery solution. Solar technology is constantly improving and this material is now available in various formats: standard solar panels, flexible solar panels and solar textiles. During the scope of this project, I focused my main research on solar panels and textiles and researched materials that could be used as the support structure or the support material in the construction of the box. These materials included Mycoboard, polypropylene and aluminum, which were evaluated based on durability, robustness, sustainability, weight and weather resistance.

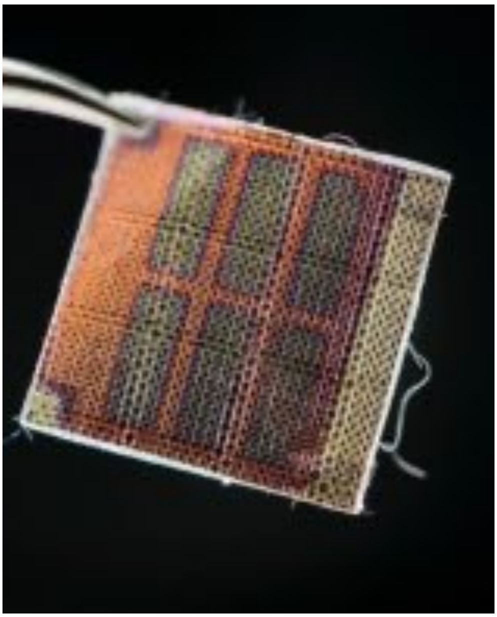
AuREUS

AuREUS, a translucent material uses technology synthesized from upcycled crop waste to absorb stray UV light from sunlight and convert it to clean renewable electricity. AuREUS can function even when not directly facing the sun, it can rely on UV scattering through clouds and by UV light bouncing along walls, pavements and other buildings. The key advantage of this material is that it does not require to be angled like most solar panels. However, because it is a relatively new material, it is not readily available. This material is available in the form of flexible films that become stiff and retain their shape when they are thermoformed.

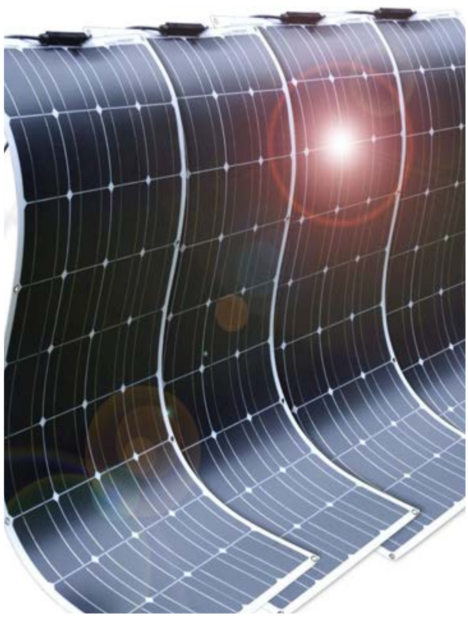
Solar Panels

Flexible Solar Panels are available in a vast variety. While some of it is under R&D, a fair amount of theis material is also available in the market. Since this technology is designed specifically for the outdoors, it is weatherproof and very durable. The fact that it can be used to harness solar power contributes to its sustainable nature. While standard solar panels are bulky and heavy, flexible panels and solar textiles are lightweight.

Solar Conductive Textile



Flexible Solar Panel



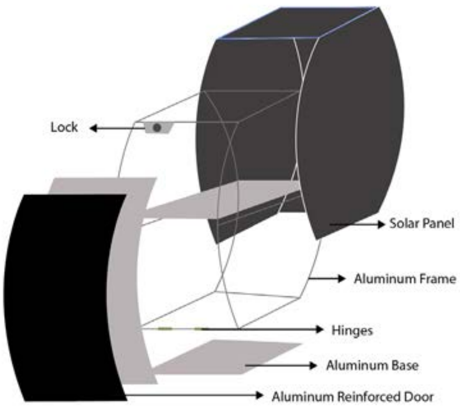
Triangulated Solar Panels

One of the most interesting formats in which solar modules are available is tri-angular solar modules, which are used in various consumer products. These are lightweight, modular and weather resistant. Since this a relatively new technology, it is expensive, however since it has an application in numerous products, the cost is predicted to lower over the next few years. An angle of 32 degrees would be the optimal angle for these to be used in Germany. However, these would still generate power at other angles as well.

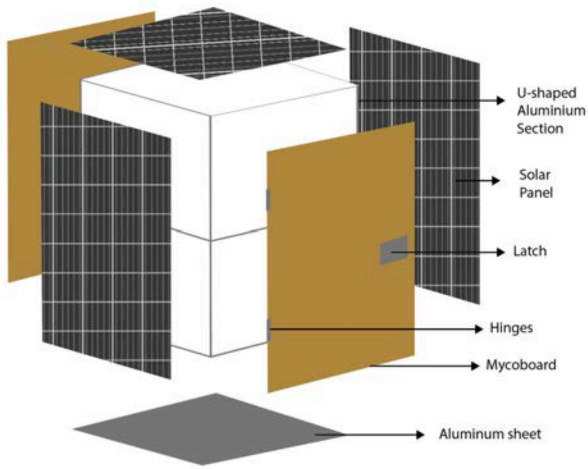
MycoBoard

MycoBoard is a pre-fabricated board that is available in the form of sheets in various thicknesses and sizes. It is grown usind a combination of Mycelium and looseagricultural plant particles. This material can be compressed with heat and pressure into boards or molded shapes It is biodegradable and very lightweight. To make it weather resistant, it can be coated with bio-coatings such as water-proof coating made of lignin or wax and starch.

Detail I



Detail II



Construction & Assembly

To understand the assembly of the current box, I visited Baecher Bergmann to have a closer look at the hinges, latches and the construction of the current box. One of the most interesting things in the boxes designed for the Deutsche Post was that tarp was being used instead of hinges and was fairly durable as a hinge. I then looked at the possible construction opportunities with solar panels. Since the flexible panel requires an internal structure to support the fabric like nature of the material, I explored using aluminium to construct the internal frame.

I also looked at understanding thermoforming that could be used to manufacture boxes made out of AuREUS. Thermoforming is a manufacturing process where a plastic sheet is heated to a pliable forming temperature, formed to a specific shape in a mold, and trimmed to create a usable product. Chamfer and Radius can ensure that sharp edges are avoided in order to make the box more durable. A draft angle of 1.5 degrees to 2 degrees for vertical drafts on female features and 4 degrees to 6 degrees for vertical drafts on male features is required. Ribs and louvers are a great design feature however, too many ribs and louvers too close together can cause excessive thinning. Small undercuts sometimes allow the part to shrink away from the mold surface and be removed straight from the tool. Normal undercuts require movable sections of the mold.

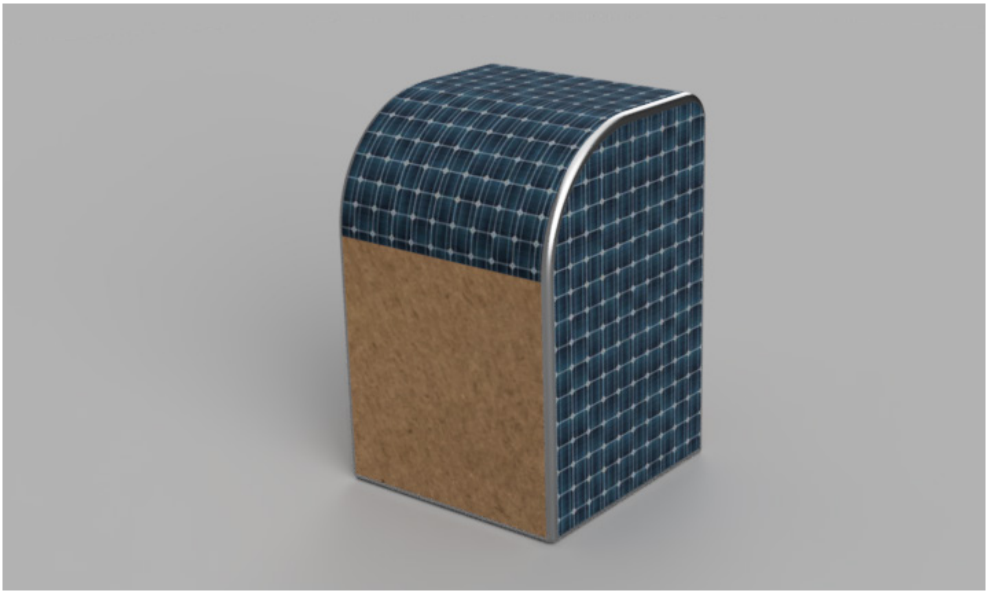
Option I

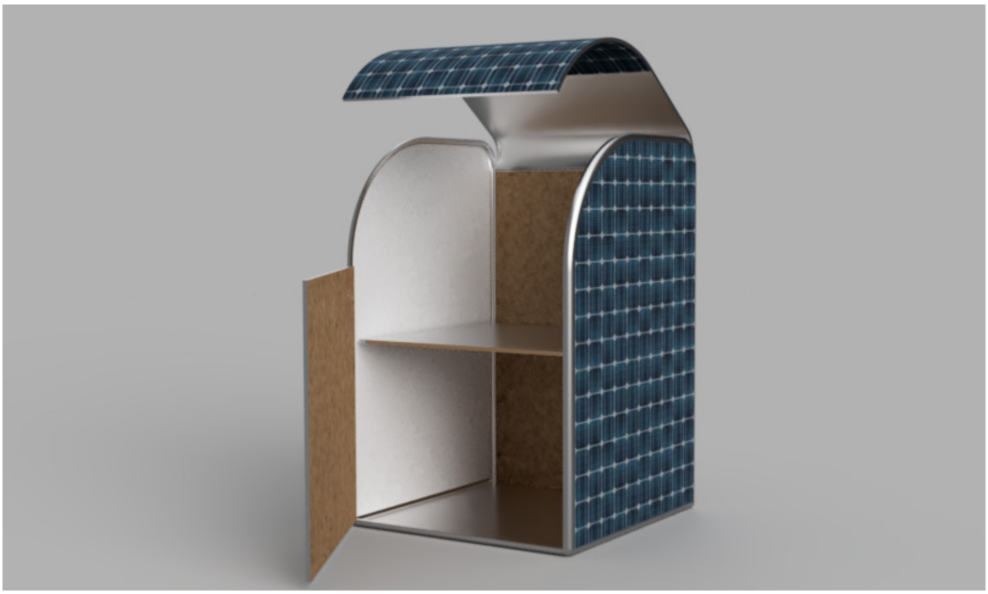
Option II

Option III

Design

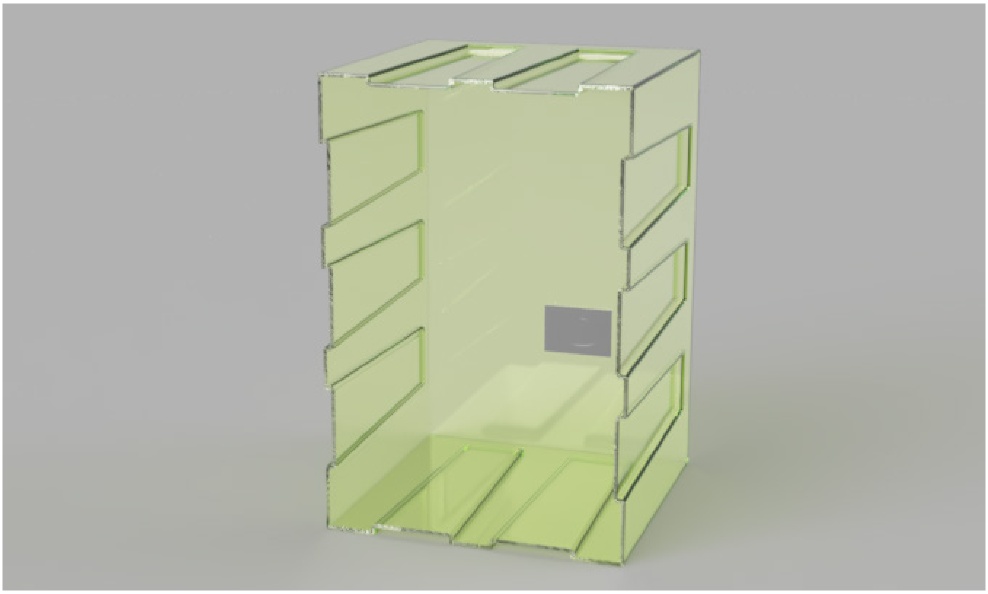
While early design ideas of the box consisted of trying to accomodate a solar panel on the roof, the later design options treated the material of solar panels as the main material for the box. Three final options were inspired by Sonic Cars that embrased the material of Solar cells. Due to the availability of Solar Cells in various formats, the three options were defined by three material formats: Flexible solar panels, Triangulated solar panels and Areus. The shape of the box was not just inspired by the material but also by the shape of the Loadster in order to create options that not only fit with the Loadster‘s language, but also have their own charachter.

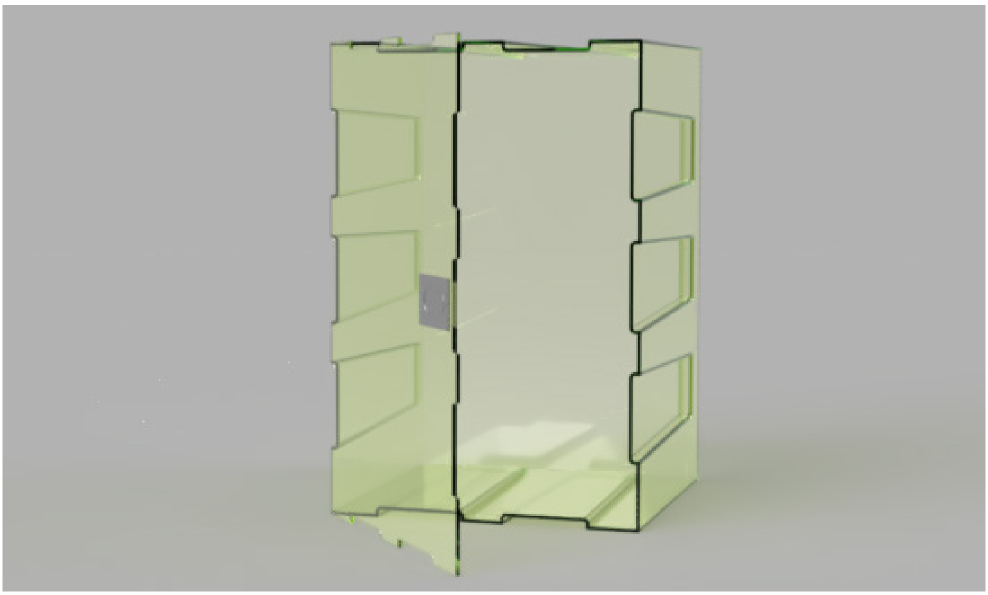




Option I

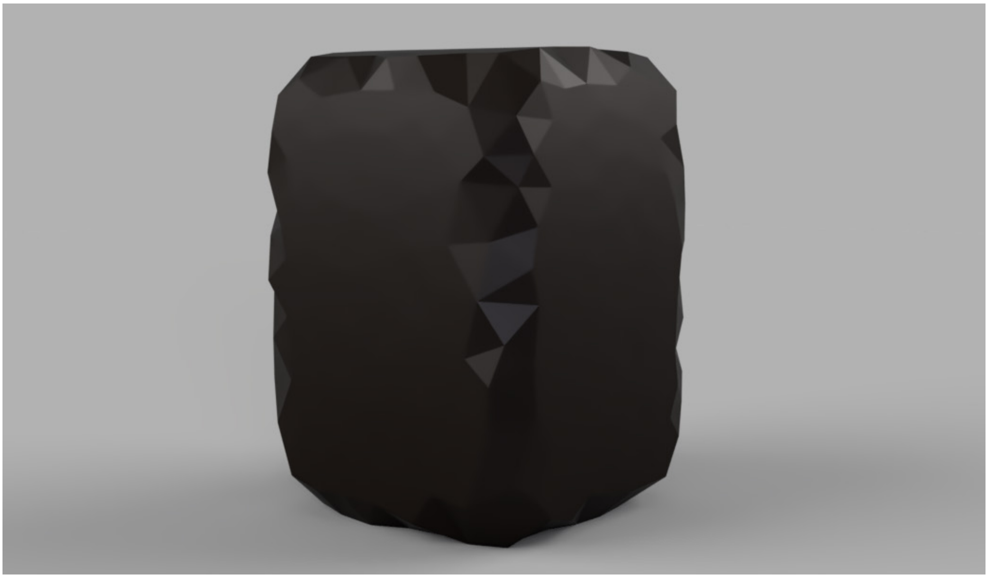
This design is constructed using an Aluminum frame in combination with Mycoboard to create a base frame for the flexible solar panel. This design can accomodate approximately 84 solar panels. Mycoboard has been used in the areas which were either prone to a lot of movement such as the door and the areas which are not exposed to any sunlight such as the back of the box.

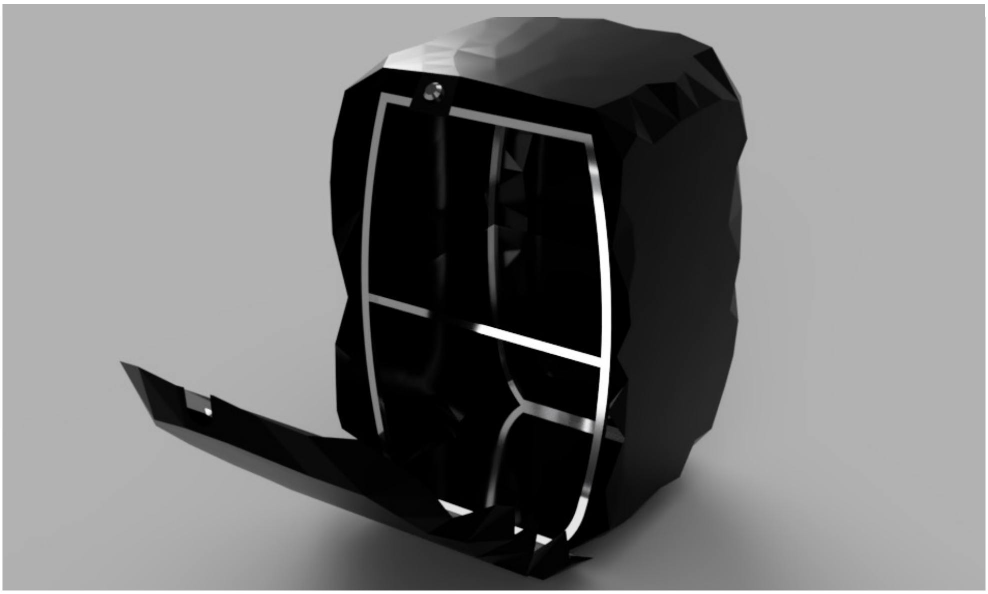




Option II

The second option is designed keeping the properties of AuREUS in mind. It is designed to be a thermoformed bos with a genorous radius and draft angle. The ribs on the sides og the box add strength to the box along with a design element. The key drawback with this design is that the box can only be manufactured as translucent which would mean that the contents of the box always remain visible.





Option III

This design is constructed using the triangulated solar panels to create a monolith-like box with a triangular texture. The internal structure is created with an Aluminum frame with two levels in order to carry more articles when requires as well as a lock to keep the contents of the box secure.

The third option was the final design that was chosen due to its aesthetics that pushed the idea of what a standard box could look like. This design, while befitting the language of the loadster, has a strong identity of its own as well.

My key learning in this course were material research and designing to push the limits of the box. Visiting Baecher Bergmann also allowed me to get a fair understanding of the production processes. During the construction and research phase, I also got a better understanding of designing for thermoforming. Overall, this course helped me learn how to generate multiple ideas quickly and to be brave and push the boundaries of design.

The Last Few Kilometers

Tong Pan

Plastic

Metal

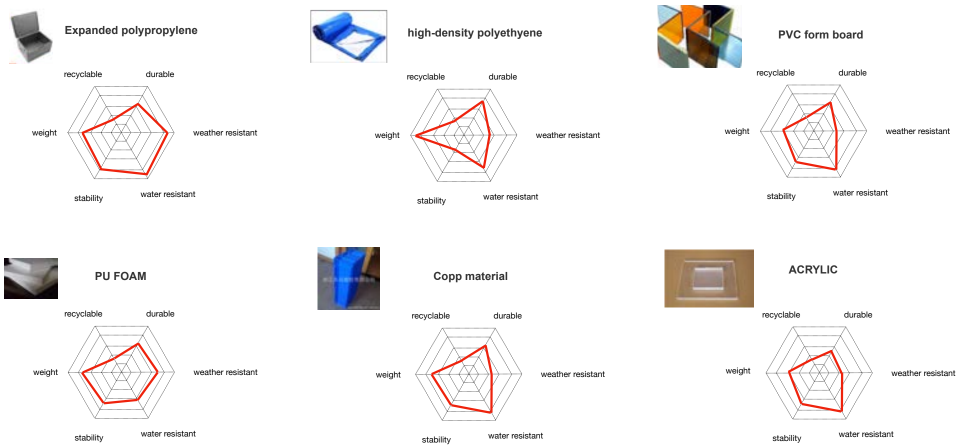
Wood

Material Research

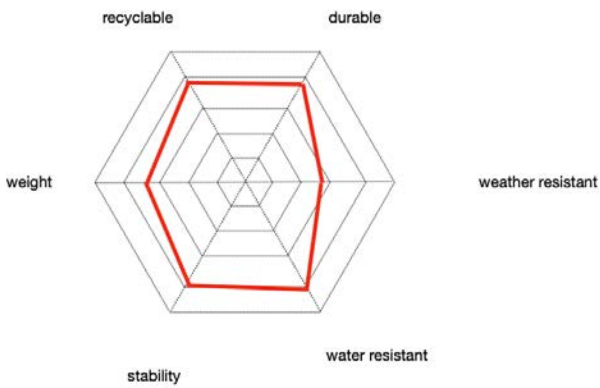
Urban cargo as a tool used to transport goods, depending on the needs of the goods, the material requirements needed are different. For example, transporting cooked food needs to be insulated, while transporting parcels needs cargo to have good capacity and water resistance. So the choice of materials is a lot.

I did an overview about the materials available on the market. For example, plastic, metal and wood. And each material I did six characteristics to analyze the advantages and disadvantages of each material. These six characteristics are based on the needs of Urban Cargo set up, respectively, water resistance, stability, recyclability, weight, weather rasistant and durable.

Plastic

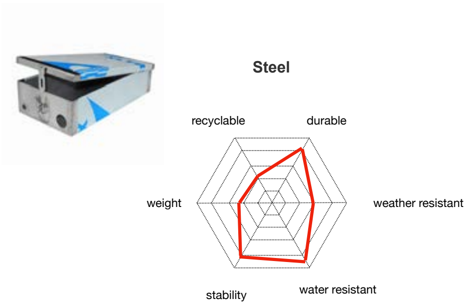


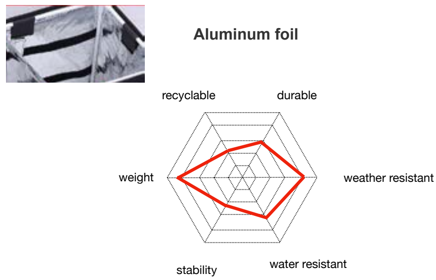
Plastic, the most common material, is available in many different types on the market. Currently on the market to transport food plastic box material is mostly EPP. Because through the processing can make a better sealing and insulation of the box, while the weight is also relatively light. But the disadvantage is that it is easy to be broken and not easy to repair. The next example in the market is wrapped in aluminum film on an HDP frame. While taking into account the insulation and weight, durability is also enhanced. But the biggest problem with plastic is that it is not environmentally friendly and has a bad impact on the environment

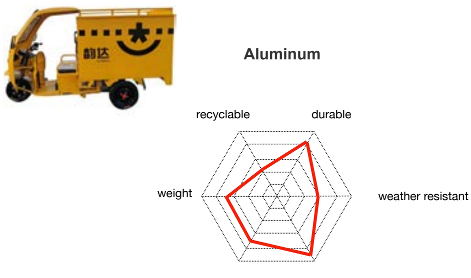


In subsequent research I discovered recyclable plastics. It is a material that is re-made by recycling plastics. It is relatively friendly to the environment. Other properties are similar to ordinary pp plastic.

Metal



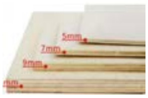




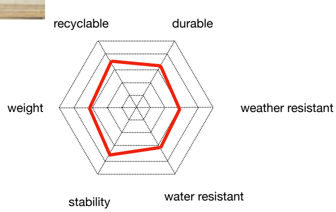
The next more popular material is metal. For example, aluminum, steel, iron, etc. Aluminum and steel are mostly used as the material for car shells. Because of its good durability, not easy to deformation, waterproof. By matching with different materials will also have good weather rasistants, and their prices are cheaper in the metal category. But the disadvantage of metal is the weight.

Wood & Paper

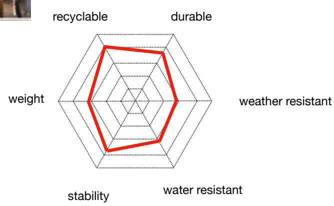
Wood and paper as recyclable materials, its very friendly to the environment. However, both are less durable. Paper, in particular, is particularly poorly water-proof. And generally wood can be heavy in weight. So these two materials are not particularly suitable for URBAN cargo.



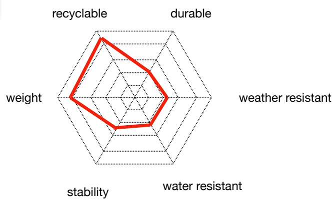
Plywood



Chinese fir



carton



Construction & Assembly

WE LIVE IN A PLASTIC ERA.

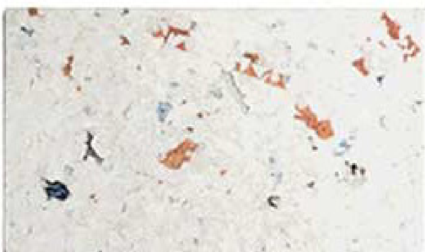
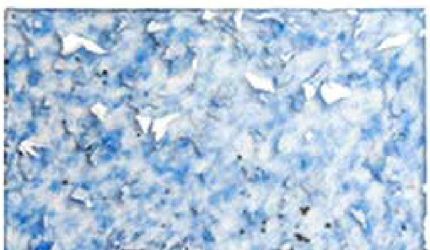
From the clothes we wear to the food we eat, plastic has become a household staple for families and communities around the world. Given its prominence, and the fact that scientists estimate it takes somewhere between 450 –1,000 years to decompose (some argue it will never decompose), it is essential for us to understand this material.

That's why people around the world have been working on recycling and reusing plastics for years. But not all plastics can be recycled, because recycling is often more complicated than throwing them away. The recycling of plastics is affected by many elements, and the types of plastics alone are very diverse. Other factors include market demand, local regulations, technical capabilities, and more. So plastic recycling is a very complicated matter. But in recent years, there are many products on the market that are made by recycling plastics. Most of them are made by recycling PP or HDPE plastics and going through a series of procedures.







Broadly, there are two major ways to recycle plastic:(1) mechanical recycling („chop and wash"), where the plastic is washed, ground into powders and melted, and (2) chemical recycling, where the plastic is broken down into monomers.
During my research I found that the current market process is generally sorted out after recycling, then shredded and cleaned up. The last stage is turned into reusable plastic granules, then heated and molded. The whole process is very simple, but basically has no impact on the environment. The most difficult part of the process, as I mentioned before, is the recycling of the plastic. There are many different types of plastics and it is very difficult to recycle them. For example, in Germany, although there is a yellow bag program, but the proportion of the real recycling is very low.

But in the recycling of plastic is very malleable, and the weight can be controlled. The most important feature is his uniqueness. Due to the uniqueness of the texture, recycled plastic is very recognizable.

Reference I

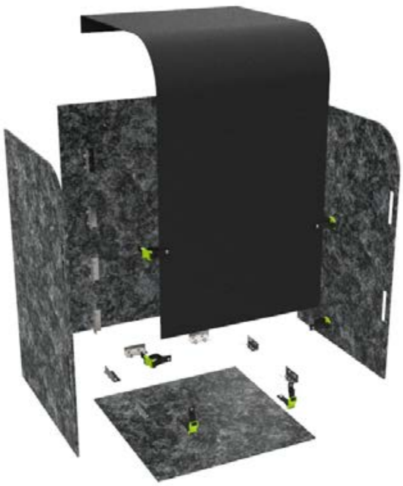
Reference II

Reference III

Design

Based on the above research, I designed a cargo box for couriers. I designed a cargo box for courier companies, because the requirements of courier companies are large capacity, waterproof, light and easy to repair. So I used the properties of recycled plastic and combined it with nylon tarpaulin to create a box with an open top. The overall dimensions are 80cm x 80cm x 120cm, because according to the requirements of the courier company(DHL), the longest side of a normal parcel should not exceed 120cm, but there are often special large parcels that need to be transported, so the open top design can cope with such situations.

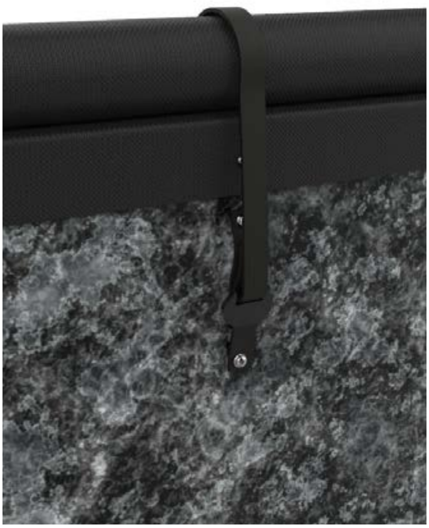
Details



The whole case is made of four recycled plastic panels and a nylon tape held together by hinges. This means that whichever part is broken, it can be repaired and replaced very quickly. The box has six quick buckles to hold the tapes in place and the courier can use the buckles for different situations, for example if the shipment is small there is no need to fasten the top two buckles.

There are total of four holes on both sides of the box. Not only for fixing the tape, but for example two straps can be also set when the box is open. This will prevent the big packages from falling out the box.

Switching between the two states is very simple. Just unfasten the buckle and roll up the cover, and then fix it.



The Last Few Kilometers

My design was inspired by the concept of the last few kilometres. Amazon is currently using this system in New York. The concept means that the parcels are transported by urban cargo or bicycles. In many parts of Asia, bicycles or electric bicycles have always been used for the final transport of parcels. The parcels are transported from the distribution centre to the truck and then to the destination city by more flexible transport devices. This is very efficient in large cities. Because the traffic situation in big cities is really complex, transporting by car can be difficult. So I believe that the use of urban cargo in big cities will increase significantly in the future, not only for transporting packages, but also in many other areas

Framed

Toni Pasternak

Cork

Algae

Soy-Foam

Material Research

To ensure a lightweight, more sustainable and stable cargo box the first step is to look at the materials it is made of. The main focus is set on rigid foams made of bio-based mass, in this case plants.

The market is full of foams that seem to be sustainable. The comparison between different materials to find out which of them are weather resistant and recyclable or better biodegradable is one of the biggest tasks. The result is an overview of three various raw materials from underwater to acreage – algae, cork and soy.

Every of those plants can get transformed in a lightweight foam with different features, that‘s why they are used in traditional crafts and as well high perfor-mance areas like sports. The usage of simple plates for the outside make them easy to fix and swap and shock resistant during the transport. Furthermore, foam plates are easy to handle during the fabrication and can get milled, sawed and sometimes lasered as well.

Cork

Cork Oak

Made of the bark from an Oak, cork is known as a sustainable and recyclable material which is waterproof and shock-resistant due to its flexibility. The advantage of a material like cork is that it stands as a visible statement for the ecological thought of the Cargo-Box. It is not necessary to hide its look or foil it, because it shows the user the beauty of natural materials by itself.

The market of materials that are cork based is huge – there are possibilities to spray it as a foam, buy it as plates or use it as a liquid.

Algae

Hardly any other material has been researched as much as algae in recent years. The rapid growth in the variety of algae material on the market will soon make it possible to process high performance foam in large quantities.

Various companies which use rigid algae foams to create sustainable surfboards make the first steps to replace materials like polystyrene or polyurethane. The very lightweight and stable characteristic of these materials is the perfect start to re-create the plastic based boxes. In a few years, we will have the opportunity to buy them in large quantities and use them as daily materials.

Algae Bio-Harvesting

Algix Solaplast Pellets

Algenesis Arctic Foam

Bloom Algae Foam

As an example of accessible material Bloom foam was one of the first more sustainable alternatives on the market. The advantages are that Bloom Foam has a big amount of algae particles, which ensure the balance of waterways, did not need much non-renewable oil and it works totally genetically modified organism and pesticide-free.

Soy Foam

Equal to algae, there are also foams made of soy beans. The plant is known for the cheap and scalable harvesting and nowadays mainly in the used as feed for factory farming. But soy is way more than that as Synprodo proves us.
They created an new EPS like foam made of soy, which is lightweight, hydrophobic, biodegradable and resistant to molding and UV-Light.

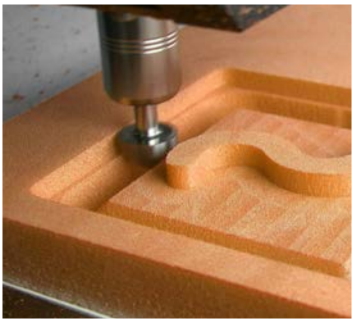
Soyfoam Insulating Box

Bio-Foam Pores

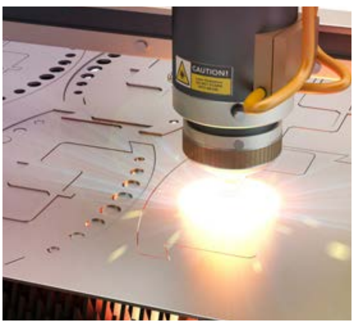
Surfboard made of Soyfoam

Production Process

Mill the Biofoam



Lasercutting Aluminum

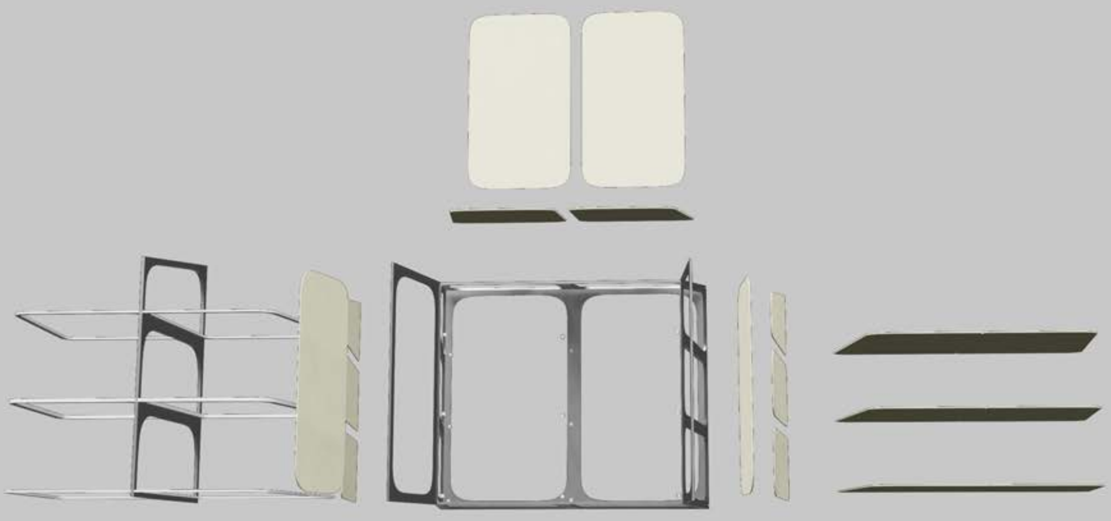


Construction & Assembly

When we ask for a vehicle for inner cities and the transportation of more or less heavy content, the need of stability in every situation is big. Traffic accidents or rickety goods are hazards that always accompany the Cargo-Bike and its driver. To ensure safety and stability in such situations, the whole box is supported by an aluminum cage.

Aluminum is not really sustainable during its production, but the opportunity to recycle it endless times like cradle to cradle make it way better during the time.

If one Cargo-Box is planned to be used for more than seven years, aluminum is a good way to safe the delivery content and the driver while not harm the environment during its use. Furthermore, it is really lightweight, relatively stable and easy to mill or laser cut to not only create a strong cage, but also make smart plugs to fix or swap the Bio-Foam panels.



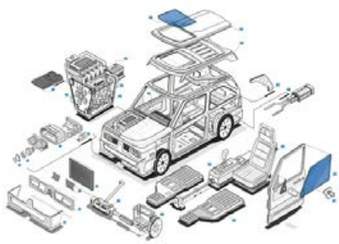
A pluggable aluminum cage keeps the whole box stiff and ensures an easy application of foam plates. There is no material mix or glue necessary, because of the modular construction of this model. All plates will fit exactly in the aluminum cutouts, while easy plug systems enable the reparation of damaged plates.

Another advantage, is the opportunity to easily change the material of the plates. If the representation of a different material is the new main focus of the design it is no problem to cut or mill it in the same form and apply it.

Tool Cabinet

Container Frame

Explosion drawing of a car

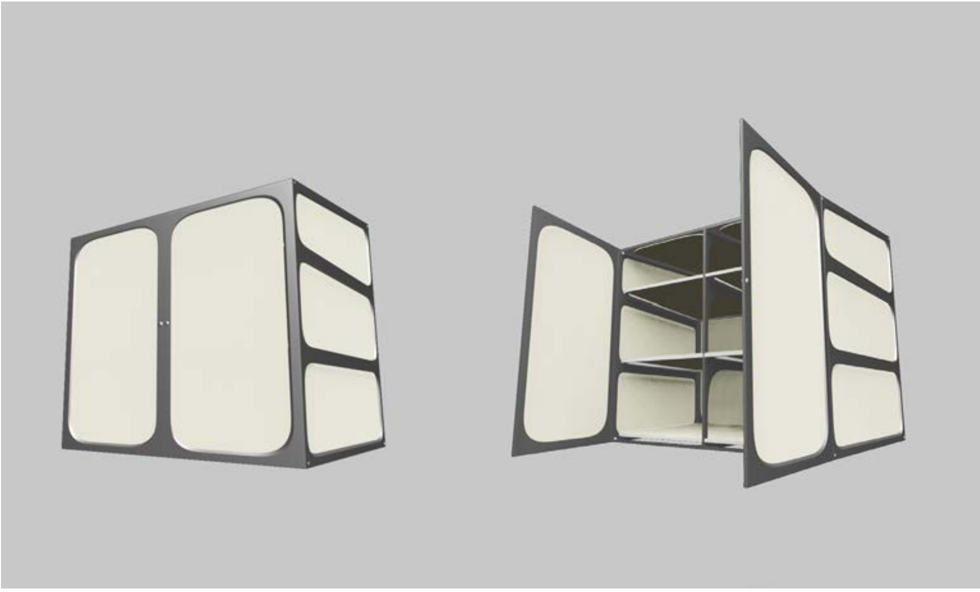


Design

The design is inspired by containers and the traditional characteristic of cars with a support structure and body parts. It is not the most aesthetical way to create such a box, but definitely one of the most easy to build and fix. The costs during the fabrication are very low due to simple forms and plug systems. Moreover, it is more easy to ship and self-explanatory during the building process.

Another point is the weight – With roundabout 28 kg total weight with an aluminum wall thickness of 2,5 mm and 1,5 cm foam plates on the inside it is really lightweight and safes a lot of electric energy during the everyday rides.

Changeable panels



Intuitive door opening

As well as the whole construction the doors work really easy and functional with hinges on the inside to provide an easy installation and usage in every situation. The doors can only get opened in the users' direction, because no other road user could crash them in that position. The roof of the box is angled to enable a better drying.


MIDSEASON
SALE

Customizable

In the end every material you are going to use has different characteristics. While Foam is more easy to paint or foil, cork is better for laser engraving without losing its interesting natural look. The amount of customizable features is endless and because of the flat surfaces everyone can easily foil it by him- or herself.

Credits

Willy Axt

Karl Breitling

Judy Elkhatib

Mallika Manchanda

Tong Pan

Toni Pasternak

Support

Prof. Dr. sc. Manuel Kretzer is professor for Material and Technology at the Dessau Department of Design, Anhalt University of Applied Sciences. His research aims at the creation of dynamic and adaptive objects with a specific focus on new smart and biological material performance and their combination with advanced digital design and fabrication tools.

Sebastian Bächer is CEO of Bächer Bergmann GmbH, a company with specialist expertise in prototyping and the production of complex shapes using computer-controlled machines.

Jonas Kremer is CEO & Founder of citkar GmbH, a company that wants to evolve and transform urban mobility.

Danny Ott, Benjamin Kemper and **Virginia Binsch** are part of the Materiability Research Group and experts in materials, design and digital fabrication.

Hans Sachs is professor for CAAD, at the Detmold School of Architecture and Interior Architecture at the University of Applied Sciences Ostwestfalen-Lippe.

Bernhard Jöckel is head and founder of Jöckel Innovation Consulting GmbH a firm that supports small and medium-sized enterprises in the strategic & operational implementation of technical innovations.