

degree PROJECT

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VT 2026

Industrial Design
Lund University

Surfboard Travel Case by **Olivia Bergman**
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School of Industrial Design
Faculty of Engineering, LTH | Lund University

Degree Project for Bachelor of Fine Arts in Design, IDELO1
Main field of study **Industrial Design**
From Lund University School of Industrial Design,
Department of Design Sciences

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LUND
UNIVERSITY

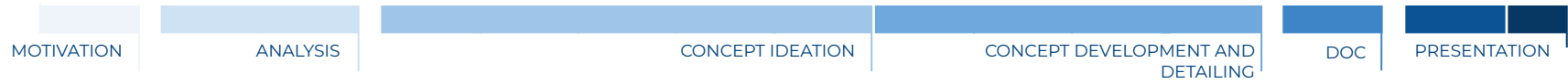
ABSTRACT

This project is developed as the final degree project for the Bachelor of Industrial Design. The project aims to show our development as designers and the skills learnt during our degree. For this project the students were the ones developing their own brief.

For this project I decided to look into how might we protect surfboards when travelling, which led to me developing a hard shell case for surfboards.

TIMELINE

14 weeks: 18/01-27/04



Motivation week 1 (18/01-25/01)

Analysis week 2-3 (25/01-08/02)

Synthesis week 4-12 (09/02-12/04)

- **Concept ideation** week 3-8 (09/02-15/03)
- **Kick off presentation** 20/03
- **Concept development and detailing** week 9-12 (16/03-12/04)

Documentation week 13 (13/04-19/04)

Presentation week 14 (20/04-27/04)

Presentation dates 28/04-29/04



MOTIVATION

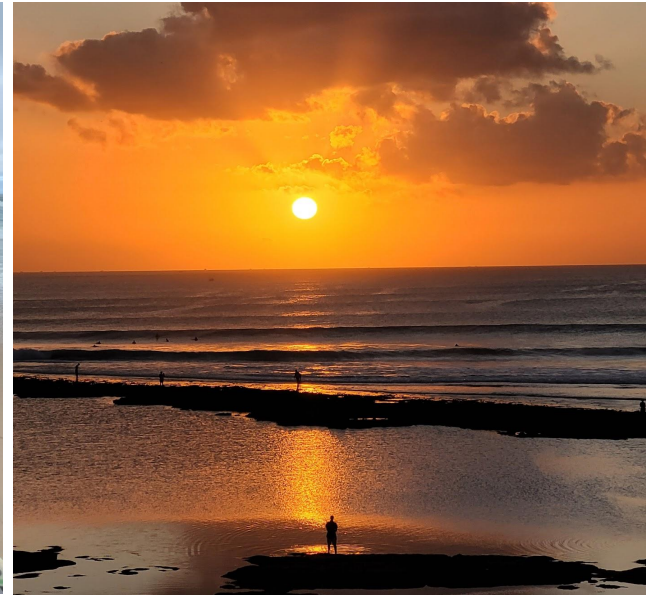
ANALYSIS

CONCEPT IDEATION

CONCEPT DEVELOPMENT AND
DETAILING

MOTIVATION

When allowed the freedom to choose my own brief I decided to explore and develop an idea that has been in my mind for quite some time. Growing up I spent most holidays in northern Spain surfing. A couple of summers ago my family and I took a trip to Indonesia, and both me and my brother had to decide if we wanted to bring our surfboards on the trip.





MOTIVATION

When you travel to surf destinations, such as Indonesia, California, Mexico, Portugal... The pictures above are how the airports tend to look like. People travel with a couple of surfboards in these fabric and foam bags. For those who are not surfers, surfing with your own board is preferred over a board rental. One is used to surfing with their own boards and knows how they respond in the water and rentals are not always available or in good condition. So, as a surfer, if you are travelling across the globe to catch that one wave, you would rather have your own boards.



OTHER THAN THE PLANE

Surfers even travel by car, motorbike and public transport to bring their boards with them on trips.



BACKGROUND

Surfboard bags are precious cargo. At least, they are to the traveling surfer. The anonymous baggage handler tossing that bag into a plane's undercarriage? Not so much. Hence why, all too often, there are **horror stories of broken boards by airlines, surf trips ruined**, and angry social media posts.



Ver más en Instagram



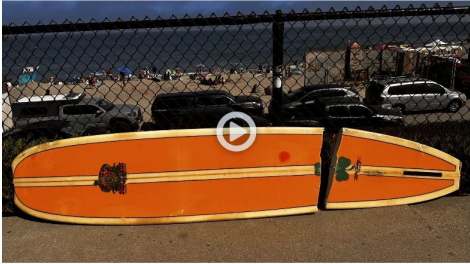
31 637 Me gusta

john_john_florence

Just wanted to say A big thanks to @jetblue for treating my poor board bag like this and telling me your not responsible !! Haha I paid 500\$ for this new shape to my board

Ver 3609 comentarios

Surfer fights airline for compensation after surfboard snapped on airplane



A snapped surfboard ruined a dream trip to California, and now the rider is fighting with Delta Airlines overcompensation.

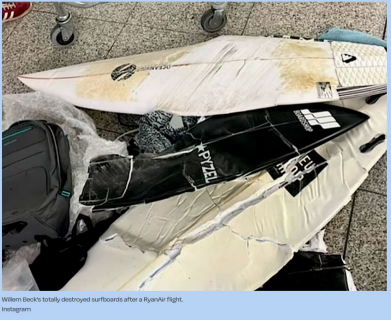
By HNIN Staff
Published Jul 7, 2024 at 1:49 AM CEST
📷 📱 📺 📻

HONOLULU (HawaiiNewsNow) - A snapped surfboard ruined a dream trip to California, and now the rider is fighting with Delta Airlines overcompensation.

"Look at this! The whole thing is in half; they broke it completely in half, and it's completely destroyed," Heather Young said.

Young cushioned her 1,500 board with yoga mats and pool noodles last month while traveling to Malibu to compete in the Queen of the Point surf contest.

But the board was in two pieces when her flight from Honolulu arrived at LAX.



Willem Beck's totally destroyed surfboards after a RyanAir flight. Instagram

Not to villainize this group of hard-working individuals who society relies on daily, but sometimes they might leave your heart sunk & jaw dropped at baggage claim wondering why? how? now what?



^ A YEIA JIF 4 Board Travel Bag violently dragged by an airline cart below shows how airline travel employees clearly don't care that 4 of your \$800 most prized possessions & essentially a large piece of your heart is carefully packaged inside.

Even with your boards packaged with our top rated Flexi Hex surfboard packaging/shipping sleeves, they might not have made it to your destination unscathed.

American Airlines Completely Demolished This Guy's Quiver and They're Protected by the Fine Print



Three of the boards in question. How, exactly, does this level of damage occur? Photos: Thompson

BACKGROUND

How to Pack Your Surfboard for a Flight

Baggage handlers don't have the best reputation. Protect your board from dings with these simple steps:

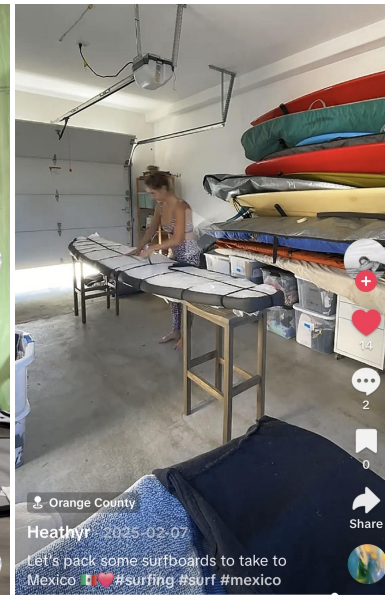
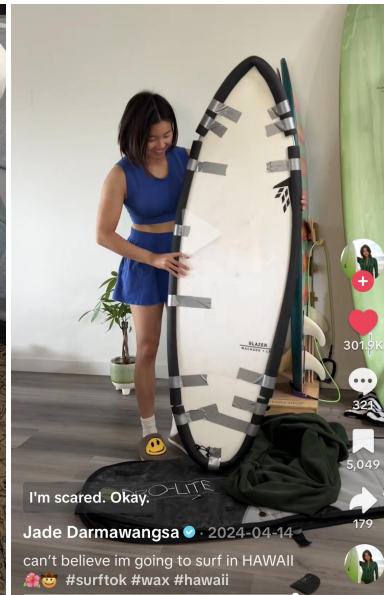
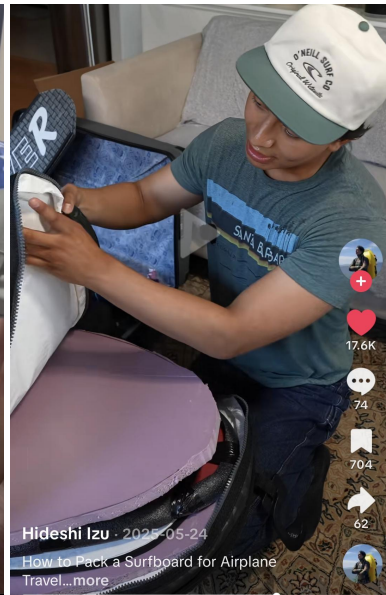
1. **Remove Fins & Leash** – Fixed fins? Wrap them in foam or cardboard.
2. **Double Wrap Rails** – Pipe insulation or towels work well.
3. **Bubble Wrap & Towels** – The more padding, the better.
4. **Duct Tape the Bag Shut** – Stops zips from bursting open.
5. **Wax Off in Hot Climates** – Melted wax on clothes isn't fun.

Bubble wrap

Additional layers
of hard foam

Pool noodles, duct tape

Towel, wetsuits...
wrapped around



MOTIVATION

After hearing all the horror stories and looking at how surfbags needed to be packed to survive the trip, my brother and I ultimately decided not to bring our boards on the trip.

When I was faced with having to develop my own brief I knew what I wanted to develop: a safe way to travel with surfboards.

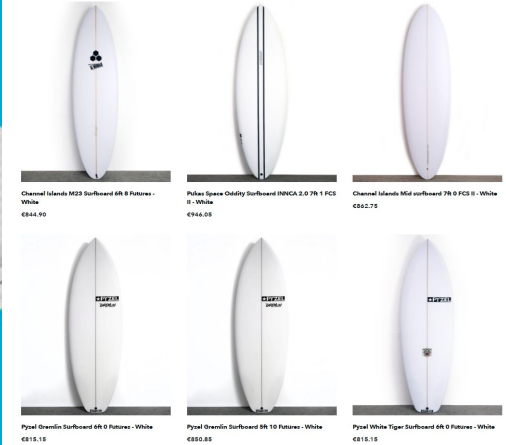
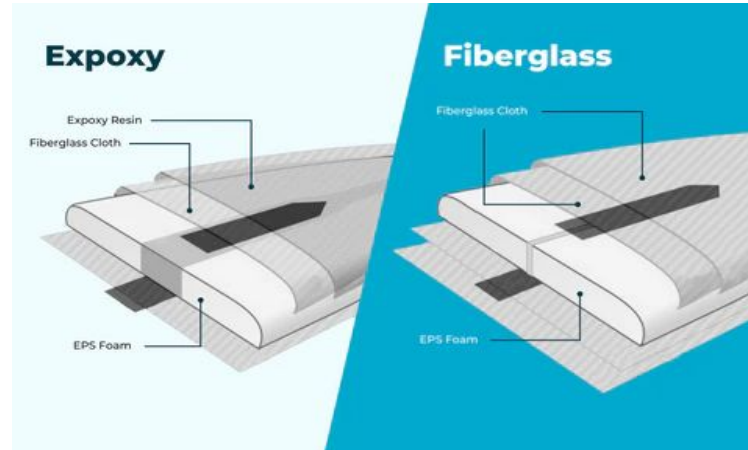


BRIEF

How can surfboards be protected while travelling?

BACKGROUND

For some more background, surfboards are made out of **fiberglass** or **epoxy**. Meaning they are quite fragile. Small bumps can cause dings and even fractures. Additionally, a board costs around 800\$. Thus, it is not only the **sentimental value** of the boards but also an **economical** one.



ORIGIN

- Early Days of Modern Surfing (Mid-20th Century): As boards became more accessible, simple cloth bags or wraps were used, but they weren't designed for robust travel.
- The Rise of Travel Bags (1980s):
 - Pro-Lite (1982): Founded by travelers needing to protect their boards, Pro-Lite became the first US manufacturer to create durable, travel-grade surfboard bags, establishing the market for them.
 - Other Innovations: Companies like Db, Veia, Ocean and Earth or Dakine later introduced innovative features like length-adjustable and compressible bags or finding ways to make them more robust, building on this legacy.

MARKET ANALYSIS

There are three main types of board bags, shown below. For this project I am going to be focusing on the **travel bags**. These bags are usually on the bigger size, with goal of fitting **3-6 boards**.



Sock



Day bag



Travel bag

MARKET ANALYSIS

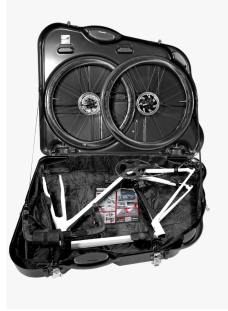
Protection



Aesthetics



Bikes



Music Instruments



Why not also for
surfboards?



Snowboard and Skis



Guns



Golf





TARGET GROUP

Age group 20-60

Geographic region Western world

Hobbie Surfing (good level)

Lifestyle Middle income, either studying, working a 9-5 or travelling the world. Every now and then gets a chance to take a trip

- Young
- Adventurous
- Active
- Social

Values Enjoys travelling around the world searching for their next adventure. Deep connection to the ocean and appreciation of nature. Slow, yet active lifestyle.

Consumption behaviour Good price-quality relationship, appreciates good equipment and is willing to invest on it.

Type of engagement Surfer, good level. Travels to surf, with their own boards.

INTERVIEW SUMMARY

For these projects I interviewed some surfers asking the following questions:

- Have you ever travelled with your surfboards?
- If no: Was there a reason why you didn't?
- If yes:
 - What was your experience like?
 - Did you use a board bag? If so, which one?
 - How did you pack your boards?
 - What were your thoughts, regarding what could happen to your board, before the trip?
 - How did your boards arrive?

The answers were varied as people have had more or less opportunities to travel. But the main answers stayed consistent.

Those who had not travelled with boards had not done this because of fear of them breaking during the trip, cost and logistics.

Those who had travelled answered that it had been a scary experience during the trip. With a lot of thought put into how to pack the boards in the smartest and most secure way. Some of them had had good experiences with the boards arriving in good condition, others not so much.

FUNCTION ANALYSIS

BASIC FUNCTIONS

High protection

Fit range of surfboards
approx 2-3

Travel restrictions

NEEDS

Durable

Minimal weight

Water resistant

UV resistant

Easy to carry

Reparable

Easy to clean

WISH

Aesthetically appealing

Economical

Have it be a part of your
board storage, not something
to hide or collapse

Environmentally friendly

OTHERS

Wheels, protected

Corrosive resistant zippers

Pockets for extras

Attached inner padding

Lockable

Thermoregulating/Isolating
material (not melt wax off)

AIRLINE RESTRICTIONS

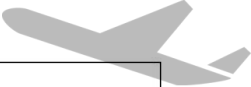
Approx dimensions:

23kg max with boards

190cm/6ft boards max

220cm/7ft boards max

250cm/8ft boards max



Airline	Fee (Each Way)	Weight Limit	Max Length	Notes
EasyJet	£45 online / £55 airport	32kg	275cm (9'0")	Pack clothes in your board bag to save on luggage fees.
Ryanair	£40 online / £55 large sports item	20kg	Not specified	Book under 'Sporting Equipment' to save money.
Aer Lingus	£40 online / £50 airport	23kg	240cm (205cm on regional flights)	Free if flying Business Class.
Jet2.com	£35 online	22kg	Not specified	Contact Jet2 directly for precise dimensions.
TUI	£30 online	Not specified	400cm (13'0")	Great for longboards!
Loganair	£20	Not specified	170cm (5'5")	Best for shortboards only.
British Airways	Included in baggage allowance	23kg	190cm (6'2")	Not suitable for mid-lengths or longboards.
Emirates	Included in baggage allowance	23-35kg	300cm (combined)	Pack strategically for the best deal.
Virgin Atlantic	Included in baggage allowance	23kg	190cm (6'2")	Additional bags cost £65/\$100 each.
Qantas	Included in baggage allowance	30kg	277cm (9'0")	One of the most surf-friendly airlines!

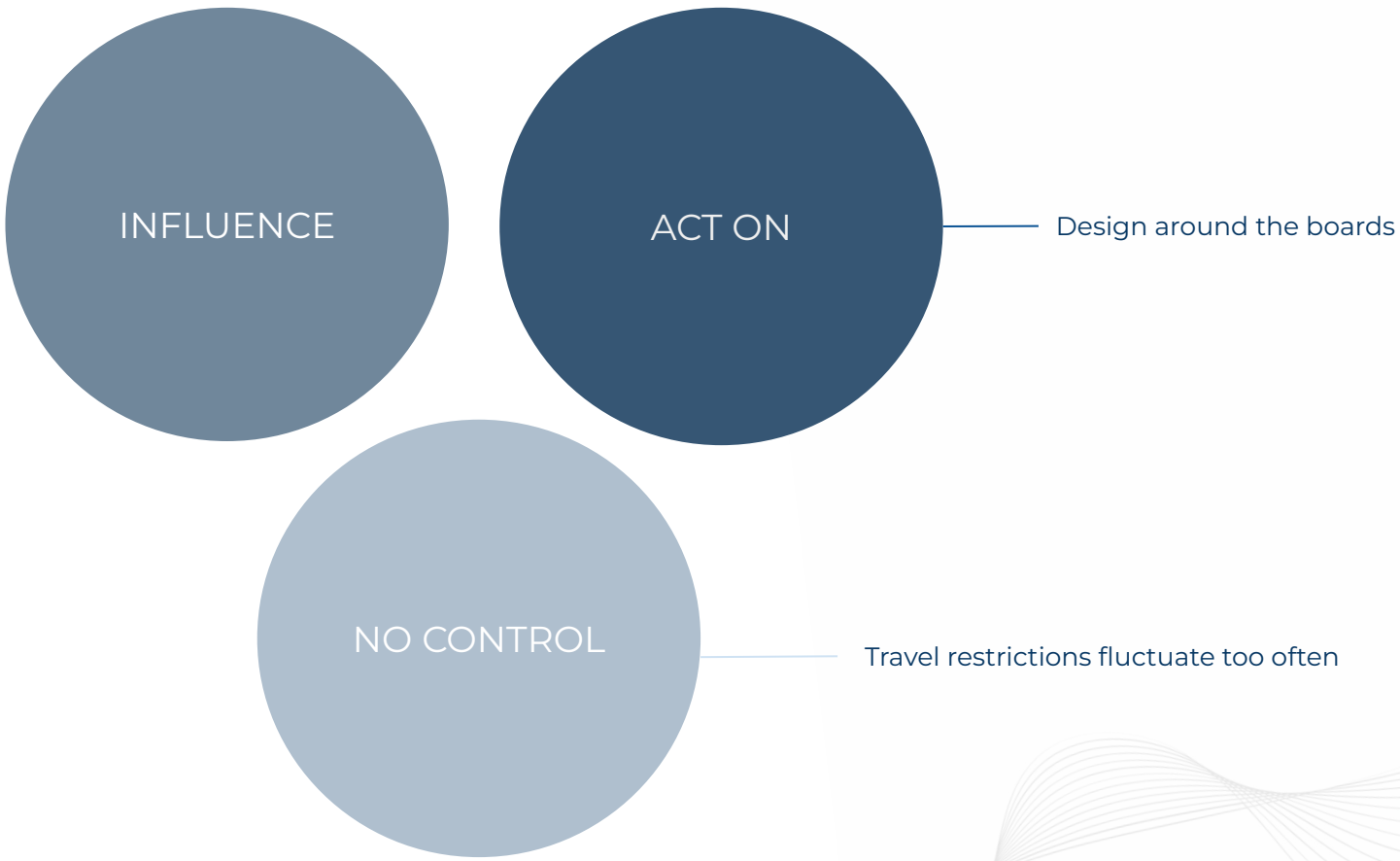
<https://www.boardshop.co.uk/blog/surfboard-airline-fees/?srsltid=AfmBOor0Cni5V5vnemiEZoUkml3lpZW-KLOz57OGFpG3GSSK5lIUfKM>
<https://freewavesurfacademy.co.uk/airline-surfboard-fees/>

OTHER THAN THE PLANE

Very hard to find
consistent rules for train
and bus travel in Europe.

Overall, really limited for
Europe but very open
outside of Europe.





INFLUENCE

ACT ON

Design around the boards

NO CONTROL

Travel restrictions fluctuate too often

WHAT IS A SHORTBOARD?

Length: Most classic shortboards fall between **5'6" and 6'6"**. Professional or advanced surfers often ride boards that are **5 to 15 cm shorter** than their own height.

Width: Standard widths usually range from **18" to 19¾"**. Narrower boards (under 19") offer more speed and control in large, steep waves, while wider boards provide more stability.

Thickness: Typical thickness for a performance shortboard is between **2½" and 2¾"**.

Volume: Most shortboards range from **23 to 40 liters**

STANDARD DIMS			
CHANNEL ISLANDS			
Dimensions			
Stock Length	Width	Thickness	Volume
5'6"	18 1/4"	2 1/16"	21.7L
5'8"	18 1/2"	2 1/8"	23.4L
5'9"	18 5/8"	2 3/16"	24.5L
5'10"	18 7/8"	2 1/4"	25.9L
5'11"	19"	2 5/16"	27.2L
6'0"	19 1/8"	2 3/8"	28.6L
6'1"	19 3/8"	2 7/16"	30.1L
6'2"	19 5/8"	2 1/2"	31.6L
6'3"	19 3/4"	2 9/16"	33.0L
6'4"	19 7/8"	2 5/8"	34.6L
6'5"	20"	2 11/16"	36.0L
6'6"	20 1/4"	2 3/4"	37.8L

STANDARD DIMS

PYZEL GHOST

LENGTH	WIDTH	THICKNESS	VOLUME
5'8"	18-3/4"	2-5/16"	24.70 L
5'9"	18-7/8"	2-3/8"	26.00 L
5'10"	19"	2-7/16"	27.20 L
5'11"	19-1/8"	2-1/2"	28.40 L
6'0"	19-3/8"	2-9/16"	29.90 L
6'1"	19-1/2"	2-5/8"	31.30 L
6'2"	19-5/8"	2-11/16"	32.70 L
6'3"	19-7/8"	2-3/4"	34.30 L
6'4"	20"	2-7/8"	36.60 L
6'5"	20-3/8"	3"	39.40 L
6'6"	20-1/2"	3"	40.10 L

DIMENSIONS

Chosen dimension to work around:

6ft surfboards

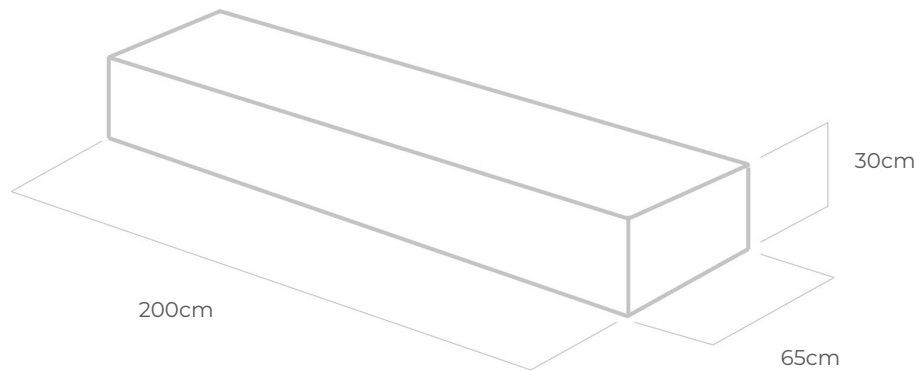
Approx interior dimensions:

6ft: 185 cm

21in: 55 cm

3in: 8 cm

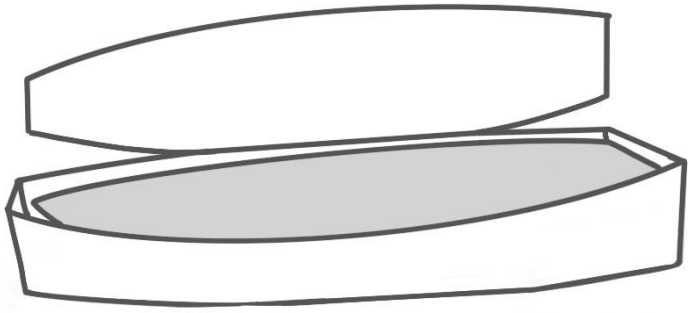
Total dim: 200/65/30xn



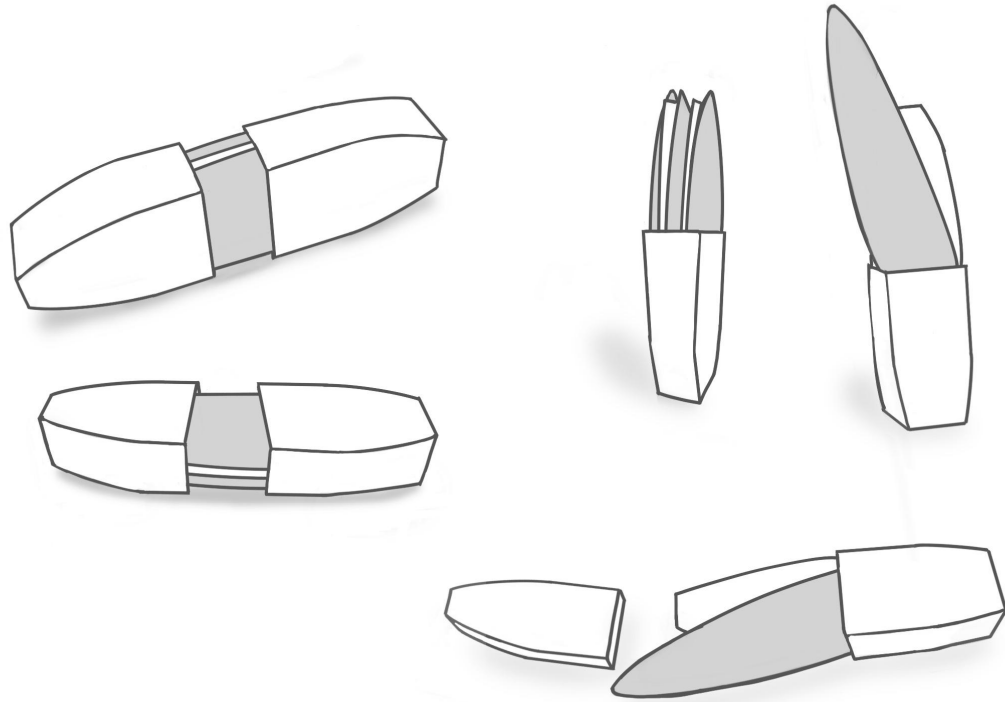


INTERACTION EXPLORATION

TOP OPENING



BOX OPENING



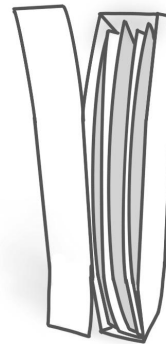
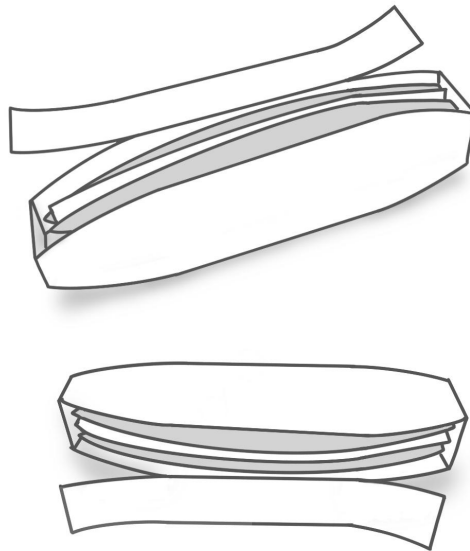
SIDE OPENING

This design was the one I decided to explore further.

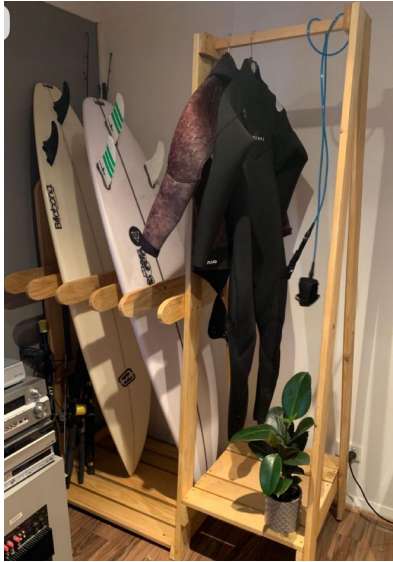
The top opening is what is most widely seen in the market nowadays but this design only allows you access to the board at the top.

The box opening on the other had gives access to all the boards, but is harder to interact with.

The side opening allows interaction with all boards while still being easy to open.

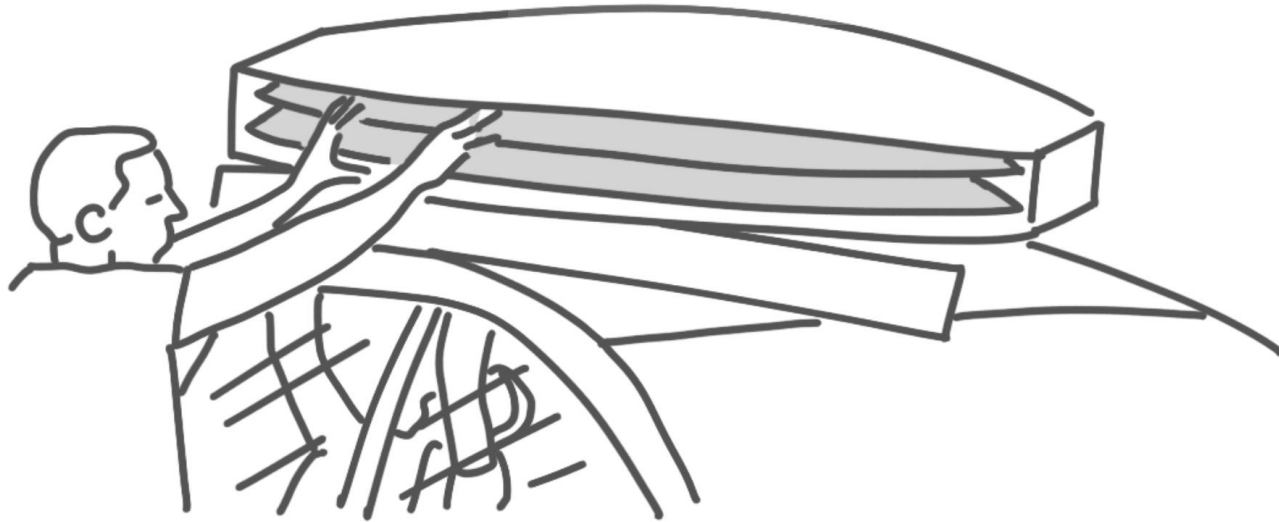


HOME/HOTEL STORAGE

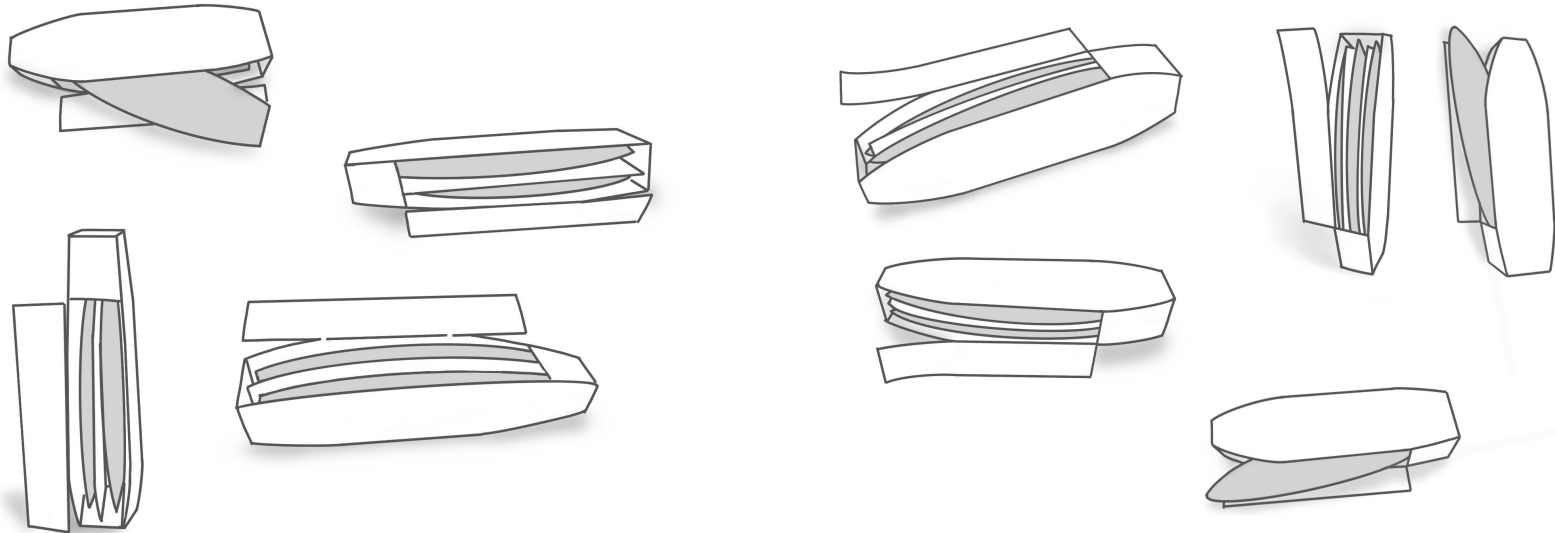




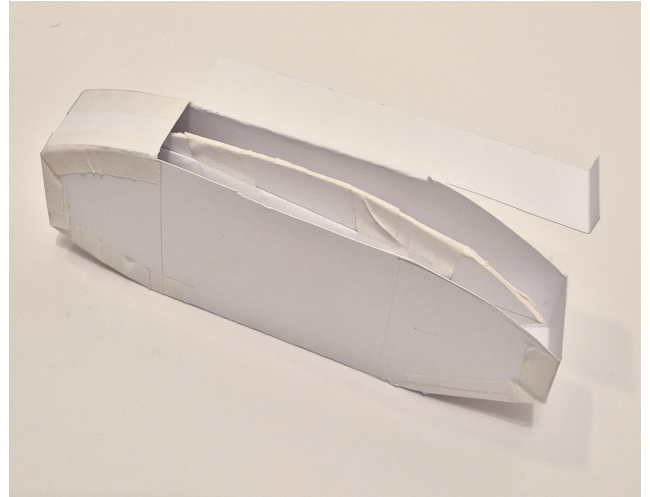
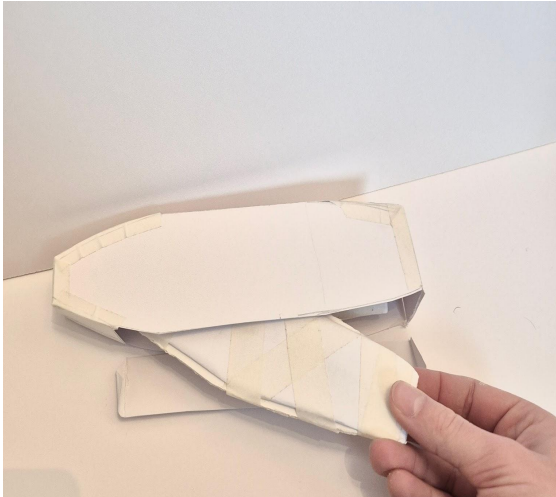
OTHER TRANSPORT OPTIONS



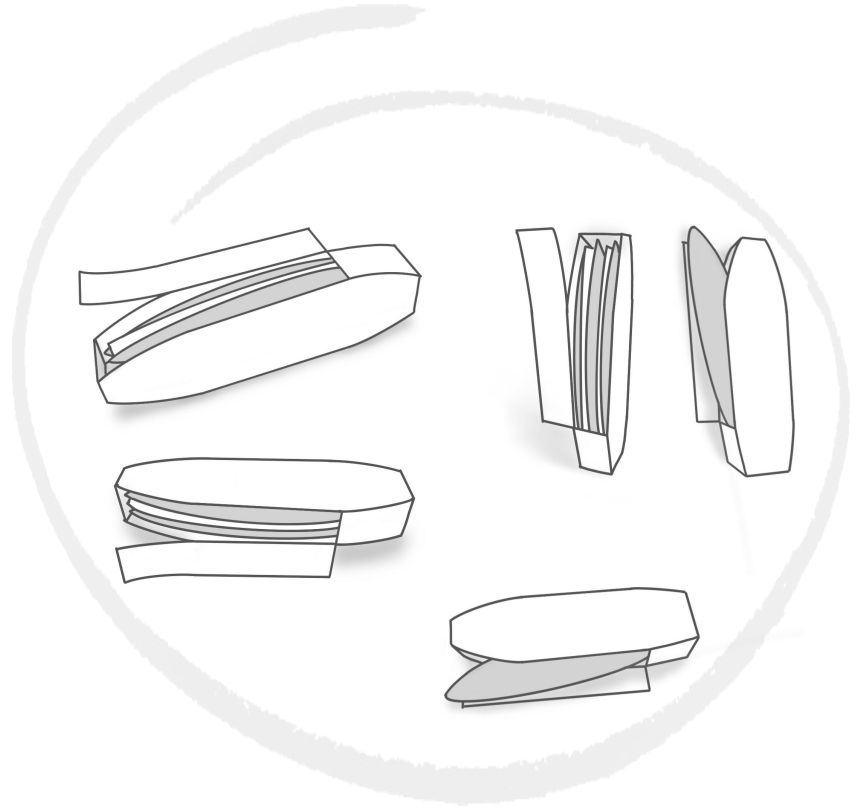
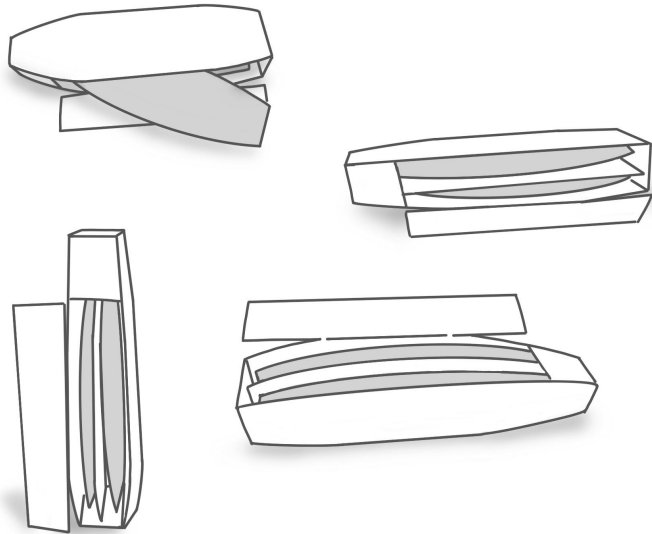
VARIATIONS



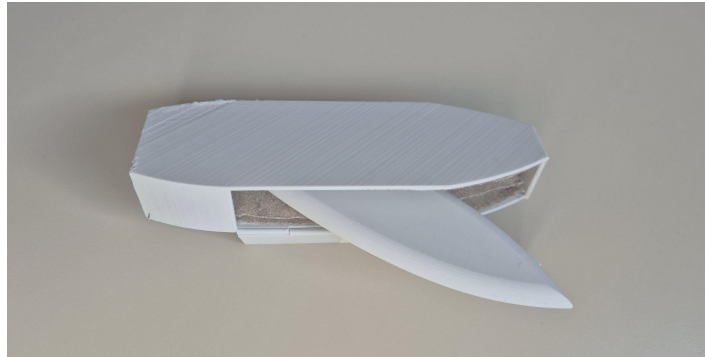
EXPLORATION THROUGH PAPER MODELS



VARIATIONS



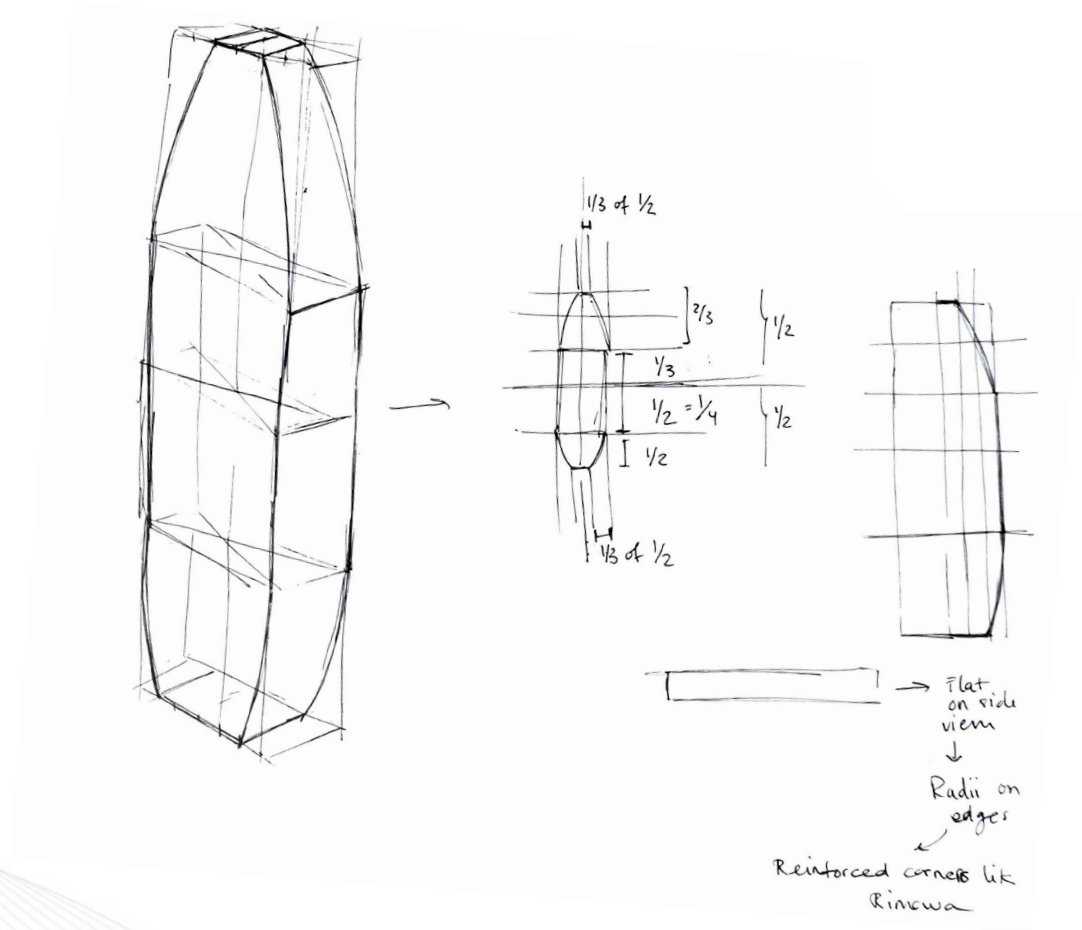
FIRST PROTOTYPES



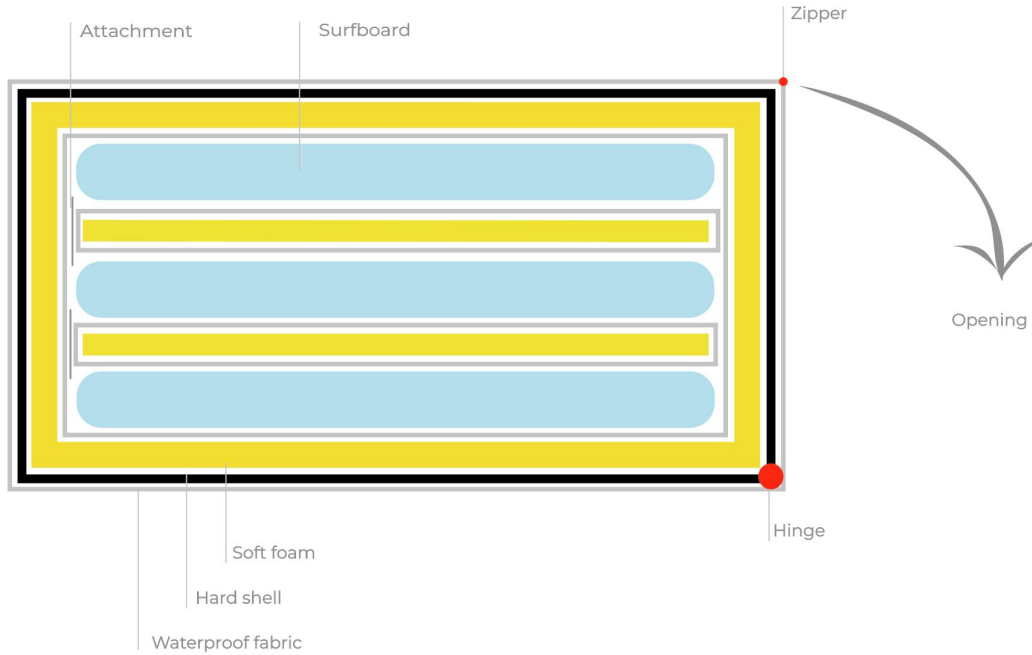
PROPORTIONS

For the main proportions of the structure:

- The bottom half is divided into two. The top part being straight while the second part curves inward tangentially $\frac{1}{6}$ of the width.
- The top half is divided into thirds. The bottom third is straight while the two top thirds are tangentially curved inwards $\frac{2}{6}$ of the width.
- All edges have a radii to soften the overall shape.



CONSTRUCTION



AESTHETIC

PELI CASE



SLEEK



GORPCORE

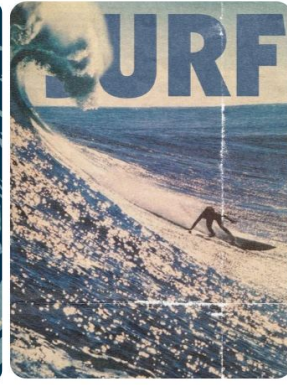
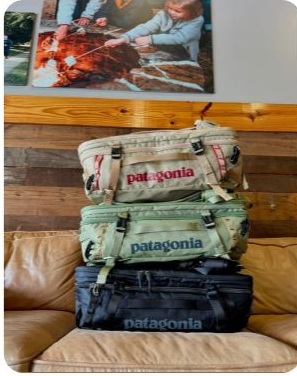


DESIGN LANGUAGE

I decided to go for the **gorp core** design language. I believe this aesthetic showcases the robustness of the product to incite reliability, while blending in with the surfer's gear.

That being said I wanted to bring a bit closer to feeling like a surf product. That is why I decided to merge the gorp core design language with the **90's vintage surfer** design theme.

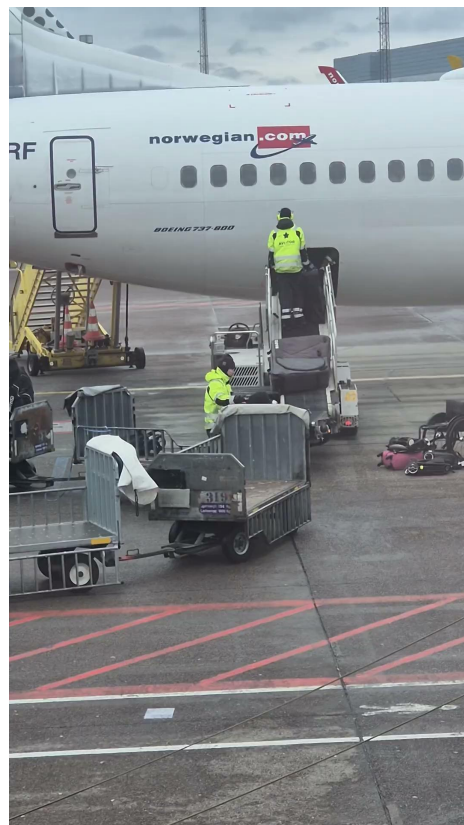
VINTAGE SURF



ERGONOMICS

BAG HANDLING







VIDEOS

These videos, taken by me at Copenhagen airport, show workers loading bikes in their respective bags onto the plane.

As one can see the bags are being tossed around without much care. These is partially due to the poor placement of handles for airport personnel.

Aside from looking at these videos to analyze ergonomics, they serve as a way to support the the issue that this project is grounded on.

BAG HANDLING ERGONOMICS

Ergonomic Baggage Handling in the Airline Industry

Baggage check-in

The challenge: Agents receive bags from passengers at a baggage check-in point. The bags are usually weighed on a scale and tagged for the destination. The agent then lifts the bags and places them on a conveyor for transport to the baggage sorting area.

The hazards:

- Tagging and lifting the bags while bent over (Fig. 1).
- Reaching with extended arms to lift and carry the baggage (Fig. 2).
- Twisting the torso while transferring the baggage to the main conveyor, which is often several feet behind the counter (Fig. 3).
- Performing the same lifting and twisting motions repeatedly throughout the shift (Fig. 4).
- Lifting excessively heavy or awkward bags (Fig. 5).
- Standing on hard floors.
- Standing in one spot for a long time.

The solutions: Train employees in proper ergonomic techniques:

- Minimize bending when lifting baggage by raising the height of the scales where the passengers place their baggage.
- Minimize lifting by tagging the baggage while it is on the scale, rather than lifting it to a temporary position on the floor and then lifting it again to the main conveyor.



Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5

- Tag all excessively heavy baggage with a tag that reads, "heavy" to indicate that it should be handled by two or more people or with a hand truck or dolly.
- Rotate employees during a shift to reduce the amount of lifting and twisting each employee performs.
- Provide a footrest 4-to-6 inches above the floor to allow employees to alternate the leg that supports the majority of their weight.
- Provide anti-fatigue mats to employees who stand for extended periods.
- Provide stools so employees can alter their posture while working behind the counter.

Automated Solutions

Some airlines have eliminated most lifting and standing hazards in baggage check-in by installing short collection conveyors to carry baggage to the main conveyor.

- The passenger places baggage on the front end of a short collection conveyor leading to the main conveyor. The front end of the short conveyor functions as a scale. After measuring the weight, the agent activates the short conveyor to bring the bag to a position next to the agent where it is tagged. Activating the conveyor again carries the bag to the main conveyor which takes it to the bag sorting area.

Baggage sorting areas



The Challenge: After check-in, the baggage is transported to a sorting area where it is organized based on the flight and destination. Employees in the baggage sorting area move bags from conveyors to carts for transport to the plane for departure, and from carts to conveyors upon arrival.

The Hazards: There are potential ergonomic hazards when transferring the baggage to and from the baggage carts and conveyor belts including:

(Continued on next page)

- The collection conveyor is low to the floor, so employees can safely step on and over to get to their workstations. The employees never have to worry about stepping on a moving conveyor, because the conveyor is stationary when not in use.

- If a belt conveyor is not practical, a series of rollers (a roller conveyor) may be used. Although the employee must pull the baggage along the rollers, with proper training this minimizes lifting and twisting.

- Extended reaching into the cart to pull bags from the far side of the cart.
- Elevated and extended reaching with arms above the shoulder while lifting bags to elevated locations inside the cart.
- Lifting from and to the conveyor while bent over with arms fully extended.
- Repeated lifting of heavy objects from a low conveyor or the floor.
- Repeated twisting of the torso while lifting the baggage between the cart and the conveyor.

The Solutions: Educate employees in proper lifting techniques such as the ones below to keep the load close to and in front of the body.

- Load heavy bags close to the cart opening to minimize heavy lifts with the arms extended.
- Establish work practices (or redesign baggage carts) to prevent stacking bags above shoulder height.
- Consider redesigning new baggage carts so they are narrower to reduce the reach with extended arms.
- Grasp the bottom of the bag when loading to elevated areas rather than using the handle.
- Rotate employees out of particularly stressful tasks.
- Raise the height of the conveyor to reduce bending and lifting.
- Park the cart at an angle to minimize twisting when transferring baggage to the loading conveyor.
- Use two or more people or a lifting aid such as a hand truck or dolly when lifting bags labeled "heavy."



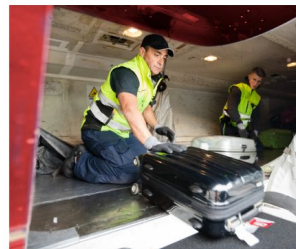
Baggage loading area

The Challenge: In loading operations, baggage is lifted onto carts or containers. A string of filled baggage carts is then pulled by a tractor to a mobile loading conveyor parked near the airplane. The baggage handlers load the baggage from the carts onto the conveyor. The conveyor then carries the load to the door of the baggage compartment, where baggage handlers place the luggage onto the aircraft for transportation. During this process, employees often work on their hands and knees because of cramped conditions. The operation is reversed for unloading.*

The Hazards: Bending, reaching, or stretching during the processes outlined below increase the risk of musculoskeletal strain.

- Repeated lifting of heavy objects from or to the loading conveyor.
- Lifting baggage with arms fully extended while bent over.
- Repeated twisting of the torso while lifting the baggage between the cart and the conveyor.
- Working in limited or confined spaces, requiring stooping, sitting, or kneeling to fit bags inside the baggage compartment.

* Larger airplanes often use mechanical baggage systems that do not require work in cramped spaces.



- Variable weather conditions add to the potential hazards such as slipping on wet and icy pavement while handling heavy baggage. Also, baggage can be more difficult to grasp securely when wet from rain or snow.

The Solutions: Train employees in the following proper ergonomic techniques.

- Park the cart at an angle to minimize twisting when transferring baggage to the loading conveyor.
- Use proper lifting techniques and lifting aids.
- Rotate employees out of particularly stressful tasks and distribute the stressful tasks equally.
- Keep walking surfaces free of ice and snow.
- Use footwear that increases traction for the conditions present.

- Consider modifying the conveyor or its placement, so it ends deeper inside the baggage compartment. (When the end of the conveyor is located on the outside edge of the door opening, it forces the handlers to reach and pull the baggage into the compartment.)

- Separate bags by weight on the baggage carts, so heavier bags can be placed on the bottom of stacks where lifting is minimized.
- Minimize the height that heavy bags are stacked so employees do not have to lift or pull with their arms

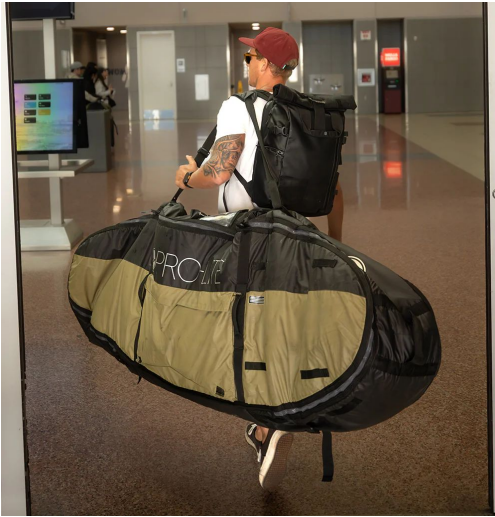
- above shoulder height. Heavy bags should be placed on the bottom.
- Consider a two-person system where one handler retrieves the bags from the conveyor and slides them to a second handler who stacks the bags in place. This will reduce twisting while lifting.
- Handle all baggage tagged "heavy" with two or more people or with a lifting aid such as a hand truck or dolly.
- Use proper lifting techniques adapted for cramped conditions inside the baggage compartment. In cramped spaces, kneeling is preferable to stooping for lifting tasks; whereas stooping is preferable for pulling tasks.
- Wear knee pads to reduce contact trauma and abrasive injuries while kneeling on hard surfaces.

BAG HANDLING ERGONOMICS

- **Move to meet the bag.** Move the body to meet the bag, rather than pulling the bag to meet the body.
- **Lift with the legs.** Bend at the knees and squat to lift heavy bags. Try to limit bending at the waist.
- **No twisting.** Never twist when lifting or carrying baggage. Point toes and the entire body in the direction the baggage should go.
- **Distribute weight evenly.** Instead of piling bags onto one shoulder or arm, distribute weight evenly on both sides of the body.
- **Keep the bag close to the chest.** When bending to place baggage in the trunk of a vehicle or a cargo hold, keep the bag close to the chest. Let the leg muscles carry the bag's weight, not the back muscles.
- **Do not rush.** Move slowly and carefully. Be aware of the surrounding space to know how much room is needed. This will limit the times the baggage may have to be lifted and rearranged.



HOW TO CARRY



MATERIALS

FUNCTIONAL ANALYSIS

High protection

Durable

Minimal weight

Water resistant

UV resistant

Easy to repair

Thermoregulating

Tear resistant

ALUMINUM CASE

Halibut, Rimowa, Bam Hightech...

PROS

- 1. Very stiff** Panels don't flex much, which protects boards from bending loads.
- 2. Strong under compression** If luggage gets stacked on top, aluminum holds shape better.
- 3. Easy to reinforce** You can rivet frames, ribs, and corners easily.
- 4. Repairable** Dents can be hammered out. Cracks can be welded.
- 5. Heat resistant** No warping if left in the sun or hot baggage areas.

CONS

- 1. Heavy** 1.5–2 mm aluminum panels add weight quickly. A full aluminum case can exceed airline limits.
- 2. Dents easily** Aluminum doesn't crack easily but **permanently dents**.
- 3. Expensive** Aluminum sheet + extrusion frames can cost more than plastics.
- 4. Cold transfer** Aluminum conducts heat/cold quickly.



**Aluminum is not the answer, but plastic
or composites might be**

OTHER MATERIALS

SKIIS

- High-Density Polyethylene (HDPE): The most common material, used in cases like Sportube and Transpack, offering excellent impact resistance and longevity.
- ABS Plastic (Acrylonitrile Butadiene Styrene): A rigid, strong thermoplastic that protects skis from crushing.
- Polycarbonate: Lightweight and incredibly tough plastic, often used for premium hard shells.
- Aluminum: Used for high-end or specialized shipping cases, providing maximum crush resistance.

BIKES

- ABS Plastic: Widely used for its durability and ability to absorb heavy impacts during airline travel.
- Polycarbonate: Known for being highly durable and lighter than ABS, allowing for easy handling while offering high impact resistance.
- HDPE (High-Density Polyethylene): Extremely tough plastic that often resists cracking, used for high-impact durability.
- Aluminum: Provides rigid, superior structural protection against crushing forces, often used in premium, high-security cases.
- EVA Foam Panels: Used in hybrid designs to add structure, rigidity, and cushioning against vibration.

GOLF CLUBS

- ABS Plastic/Polycarbonate: Known for exceptional impact resistance and rigidity to protect clubs from crushing.
- Ultra-High Molecular Weight Polyethylene: A highly durable, military-grade material often used for heavy-duty protection.
- Molded Plastic: A common, durable option that provides a solid, rigid "coffin" style shell.
- Hybrid Material Combinations: Often combine a rigid hard-shell top (like ABS) with high-density EVA foam padding or tough, soft-sided nylon bodies for a mix of protection and portability.

GUNS

- Hard Plastics / Polymers (Polypropylene, ABS): High-density polymers are the most common, offering lightweight durability and impact resistance. They are often designed to be weatherproof and are the standard for most recreational and tactical cases.
- Aluminum: Chosen for maximum strength, rigidity, and a professional look. These offer excellent protection for air travel but are generally heavier than plastic cases.
- Composite Materials: Often used in higher-end cases to combine the strength of materials like fiberglass with the lightweight properties of plastic.
- Interior Materials: Interiors are lined with high-density egg crate foam or customizable "pinch-and-pluck" foam to keep firearms secure and cushioned.

MUSIC INSTRUMENTS

- Plywood/Wood Laminates: A traditional, sturdy choice covered in vinyl, Tweed, or Tolex for moisture resistance.
- ABS Plastic: Popular for being lightweight, durable, and resistant to impacts.
- Fiberglass: Offers excellent impact and pressure resistance, often used for waterproof, high-end cases.
- Carbon Fiber: Provides the best strength-to-weight ratio, offering maximum protection with minimal weight.
- Aluminum: Commonly used for "flight cases" or road cases, providing extreme durability and structure for heavy travel.

Abs plastic
Aluminum
Carbon fiber
Fiberglass
Polycarbonate
HDPE
Polypropylene

SHELL MATERIAL COMPARISON

Material	Weight (for large shell)	Impact Resistance	Structural Stiffness	Dent / Crack Behavior	UV & Weather Resistance	Manufacturability (large shells)	Relative Cost	Suitability for Surfboard Travel Case
ABS Plastic	Medium light	High	Medium	Can crack after repeated impacts	Moderate (needs UV additives)	Excellent (thermoforming)	Low	Good balance
Aluminum	Heavy	Medium	Very high	Dents easily but rarely cracks	Excellent	Moderate (sheet forming + rivets)	Medium–High	Too heavy
Carbon Fiber	Very light	Low–Moderate	Extremely high	Brittle → cracks on sharp impact	Excellent	Difficult & expensive	Very high	Overkill + fragile
Fiberglass	Medium	Moderate	High	Can crack but repairable	Very good	Good (molding)	Medium	Good
Polycarbonate	Medium	Extremely high	Medium	Very hard to break, flexes instead	Very good	Good (vacuum forming)	Medium	Excellent
HDPE	Very light	Very high	Low	Flexes instead of cracking	Excellent	Good (rotomolding)	Very low	Very durable but flexible

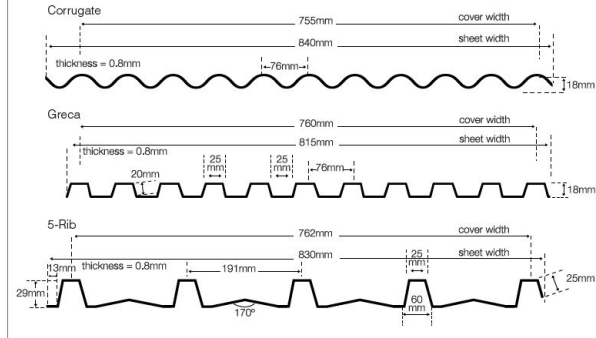
*This was done with help of AI and verified by both myself and external sources

Material	Impact Resistance	Relative Weight	Cost	Key Pros for this Use Case	Key Cons for this Use Case	Overall Suitability
Polycarbonate (PC)	Very High	Moderate/Light	Medium-High	Excellent impact absorption; bends instead of breaking; lighter than ABS.	Can scratch easily; more expensive than basic plastics.	Excellent. Top tier for standard travel cases.
Polypropylene (PP) <i>(Added)</i>	High	Lightest Plastic	Low-Medium	Very lightweight; highly resilient to drops; resists cracking well.	Not as rigid as Polycarbonate; can scuff.	Excellent. Best balance of weight, cost, and durability.
ABS Plastic	Medium-High	Moderate	Low	Very rigid; budget-friendly; easy to thermoform.	Prone to cracking under heavy impact, especially in extreme cold.	Good. A standard budget option, but slightly heavier/brittle.
Fiberglass	Medium	Heavy	Medium	Easy to patch and repair yourself (same materials as your board).	Brittle under blunt impact; heavy for a 200cm case.	Fair. Heavy and easily damaged by baggage handlers.
HDPE	Very High	Very Heavy	Very Low	Nearly indestructible; extremely cheap and scratch-resistant.	Very dense/heavy; lacks rigidity over large spans without thick walls.	Fair. Too heavy for air travel at this scale.
Carbon Fiber	High (Stiffness)	Extremely Light	Very High	Unmatched strength-to-weight ratio; highly rigid.	Can shatter under localized, sharp impacts; prohibitively expensive.	Niche/Poor. Great weight, but too expensive and brittle for airports.
Aluminum	High (Denting)	Very Heavy	High	Unyielding structural protection; extremely long lifespan.	Dents permanently; far too heavy for a 200cm flight case.	Poor. You will max out airline weight limits on the empty case alone.

*This was done with help of AI and verified by both myself and external sources

RIBS

PROFILES



Ribs: 10 mm height

Rib spacing: 100 mm

Corner radius: 20 mm



Polycarbonate

High resistance
Used for protective gear, riot shields, and hard luggage
Good stiffness while still absorbing impacts
Likely the most durable premium option

ABS

Used in many hard-shell suitcases
Easy and cheap to thermoform
Good stiffness and impact resistance
Slightly less tough than polycarbonate

HDPE

Extremely tough and flexible
Won't crack easily
But large shells may feel too floppy without ribs or frame

Carbon fiber

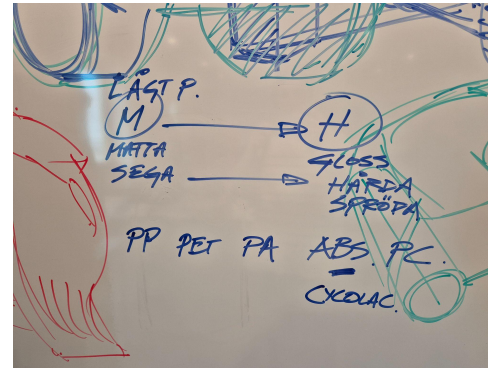
Very stiff and light
But brittle for baggage handling
Expensive and hard to repair

Aluminum

Strong but very heavy
Dents easily from baggage handling

Fiberglass

Common in boats and boards
But cracks from point impacts



After confirming with some external sources I chose Polycarbonate for this project. Specifically **PC Makrolon**. A higher end PC recognized for its **robustness** and **finish**. Furthermore this material is also highly **recyclable**.

“GOOD” BAGS

Veia

- Exterior: The bags are made from a durable 600D **Cordura fabric** (some models listed as 300D Cordura).
- Padding: They feature 10mm foam padding on the top panels and sidewalls, with 20mm reinforced padding on the bottom panel and reinforced nose/tail end caps.
- Zippers: The bags use heavy-duty, **corrosion-resistant YKK zippers**.
- Internal Features: Includes padded board separation panels to keep boards apart and a heat-resistant reflective liner to protect boards from sun damage.
- Handles and Structure: Features **neoprene main handles**, a molded rockered shape to match surfboard rocker, and a Multiband™ **outer loop for securing the bag on racks**.

Pro lite

- External Material: 600D (Denier) Ripstop Poly or Nylon for durability.
- Padding: 10mm travel-grade foam throughout the bag.
- Protection (Armored Models): Pliable polyethylene panels for top/bottom protection and inflatable rail bags.
- Zippers: #10 PK molded non-corrosive zippers.
- Interior: **Reinforced nose/tail** patches and often an **internal seat belt strap system**.
- Optional Features: Some models feature roller blade wheels

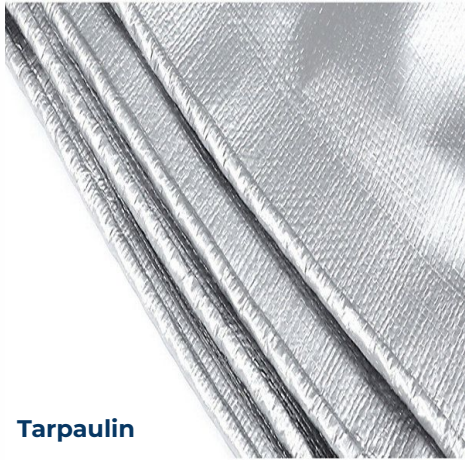
Db journey

- Main Fabric: 100% Chemically Recycled Polyester (600D to **900D**).
- Lining: 100% Polyethylene **Tarpaulin**.
- Padding: 10mm Polyurethane (**PU**) **Foam** padding throughout the body, with additional 15mm padding on the nose and tail.
- Protection Structure: Patented Rib Cage Technology, which consists of strong, lightweight foldable ABS/Polyethylene plastic ribs.
- Reinforcements: The base uses 900D recycled polyester with a PU coating and water-repellent finish

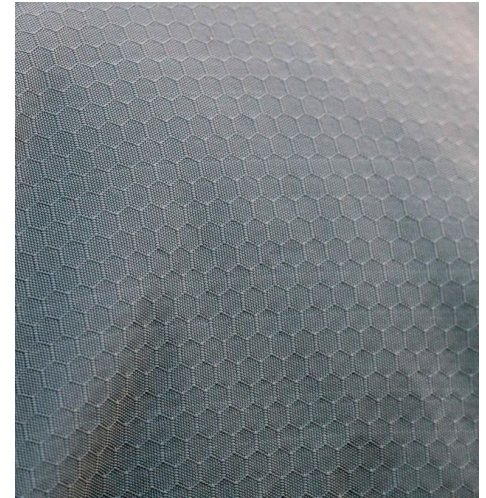
FABRIC MATERIAL COMPARISON

Material	Durability & Abrasion	Puncture Resistance	Weight (Relative)	Best Use Case
1050d Ballistic Nylon	Highest	Maximum	Very Heavy	Professional "coffin" bags for 3+ boards.
1680d Ballistic Nylon	Very High	Excellent	Heaviest	Industrial/Military grade; often overkill for surf.
900d Cordura (Nylon)	High	High	Medium	The "Gold Standard" for long-distance travel.
900d Polyester	Moderate	Moderate	Medium	Budget-friendly; lacks the tensile strength of Cordura.
600d Polyester	Low	Low	Light	Day bags; thin material prone to fin punctures.

*This was done with help of AI and verified by both myself and external sources



Tarpaulin



Hex-Ripstop silver

More expensive and not fully reflective or waterproof, lighter though

FABRIC MATERIAL CHOICE

After looking at other bags in the market and doing fabric comparison research for the outer protective cover I chose **900D Cordura Nylon**. Commonly used for heavy duty, but not as heavy as the 1500D fabrics.

For the inner fabric I needed something waterproof and insulating, so I chose **Tarpaulin** another common fabric in the industry.

CONSTRUCTION

Shell **PC: 2.5** mm

Ribs: 10mm

Interior foam: 6mm **EVA** and extra 3mm **PU foam** along nose, tail and rails

Fabric: Cordura **900D** and **Tarpaulin**

Component	Weight (kg)
Case	12
Surfboards (3)	8
Wetsuit	2
Small items	2
Total	24 kg

*This was done with help of AI and verified by both myself and external sources



SKETCHES

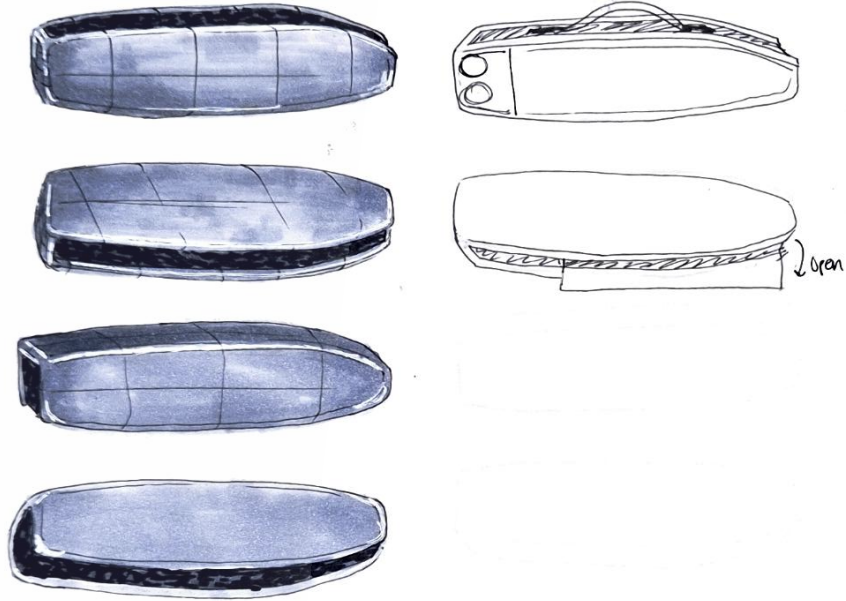
CONCEPT 1

Top and bottom plastic
Side fabric



CONCEPT 2

Top and bottom plastic
Side fabric
Sandwich

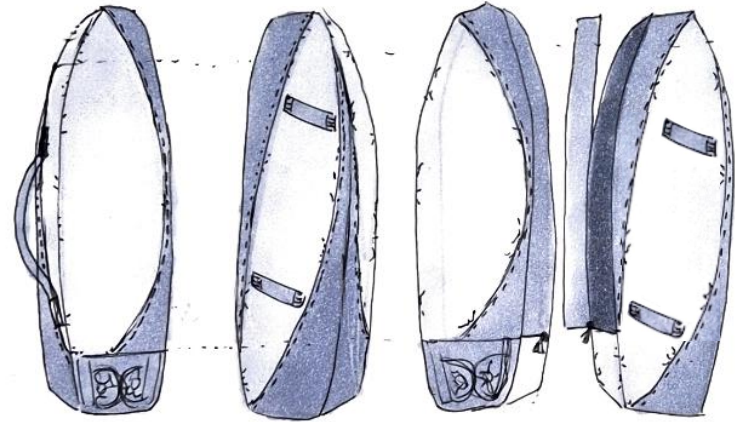
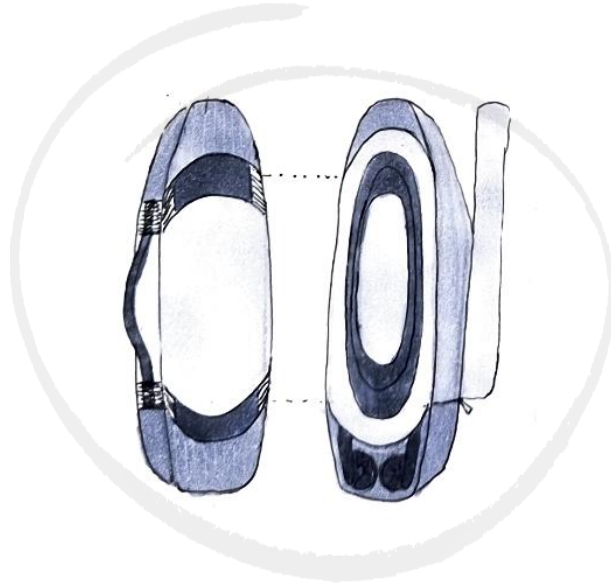


CONCEPT 2 :



CONCEPT 3

Fabric
Play around with abstract shapes



MANUFACTURE

COMPARISON OF MANUFACTURING PROCESSES

Deep Drawing VS Injection Molding.

While **injection molding** allows for lower tolerances, more even wall thickness and nice finish on both sides, due to the size of the object the risk of warpage and sink marks due to uneven shrinkage is too high, additionally for an assumed production of 10.000 units the tooling cost for this process is incredibly high and the final product will be heavier.

Consequently deep drawing, which in the case of polycarbonate is often **thermoforming**, as the plastic sheet is heated before deformation, is the chosen process.

This process is better suited to the **larger geometry**, even with elliptical ribs and indents for wheels as long as these are properly drafted, because my maximum depth ratio is quite low, my geometry is on the simpler side. Specifically, the **maximum depth ratio** in this case is approximately around 0.25 overall, which is lower than the limit which is at around 1.5-2. The biggest downside of thermoforming is **uneven wall thickness**. In this case, the geometry is simple and the maximum depth ratio is low, which means that if I start with a 4mm PC sheet my thickness will be between 2.8-3.2mm which is right where I need it to be. The only part that could potentially be thinner are the wheel indents, but these will be **reinforced with 3mm marine grade aluminium**, which solves this issue.

Thermoforming is not ideal for **tight tolerances**, but in this case they are not strictly necessary, as the part that requires highest tolerances is the door opening which will be **CNC cut** and the holes to attach the wheels will be reinforced.

When it comes to **surface finish**, thermoforming only allows for proper control over one of the surfaces, which in this case is not an issue as the inner surface will be lined with foam and covered in tarpaulin. Allowing for the **contrast of high gloss and matte texture finish**, as long as the matte texture is not too rough, which it is not. In order to have this control a female pressure forming tool would need to be used and the part where the wheels are attached would have to be glossy, due to the lower draft angle and tighter radii.

THERMOFORMING/ DEEP DRAWING

The main part, the hard shell will be **thermoformed in three parts:** the top shell, the bottom shell and the “door”.

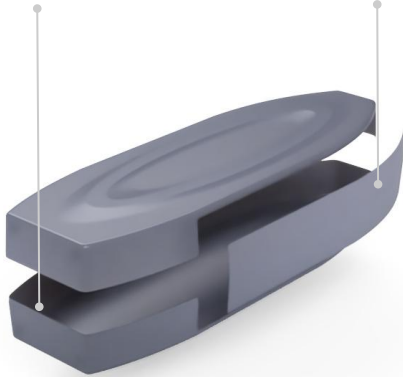
In order to produce it this way I have added a **4 degree draft angle** on all vertical faces of the piece to be able to remove the product from the molds. Additionally the ribs that add sturdiness, which in this case are elliptical for design purposes, are also drafted and so are the wheel indents, which are additionally **reinforced with marine grade aluminum where the wheel is attached.**

Both pieces of the mold end in a **200mm straight rim**, used as an attachment point. Both pieces get adhered by **adhesion bonding with marine grade adhesive** commonly used in boats. The door on the other hand is **CNC cut out** after both shells have been adhered and attached through a zipper on three of the sides and fabric on the fourth to create the hinge mechanism.

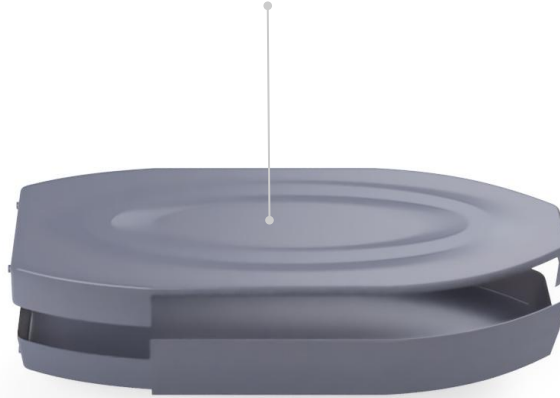
MANUFACTURE

Bottom

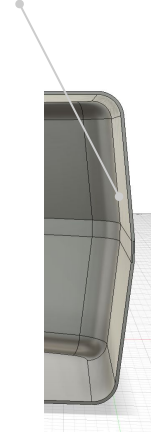
Door



Top

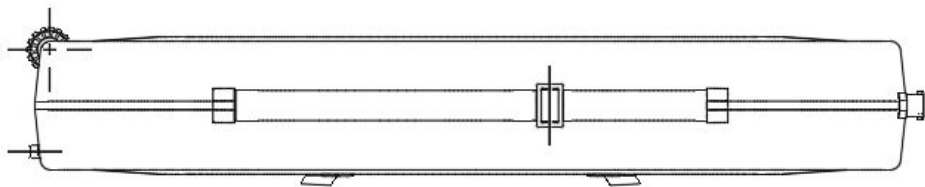
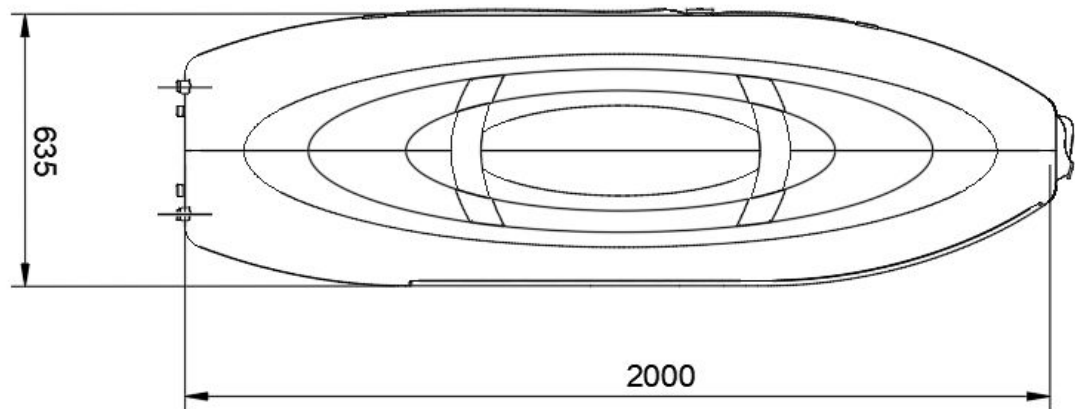
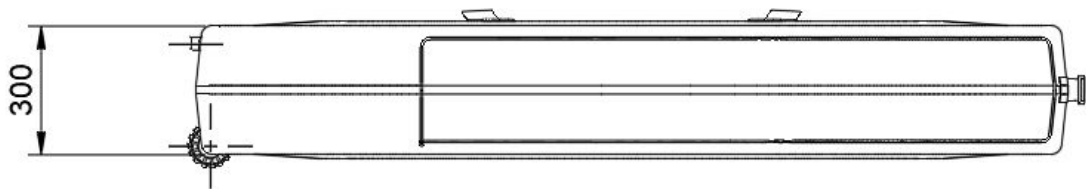


4° draft angle



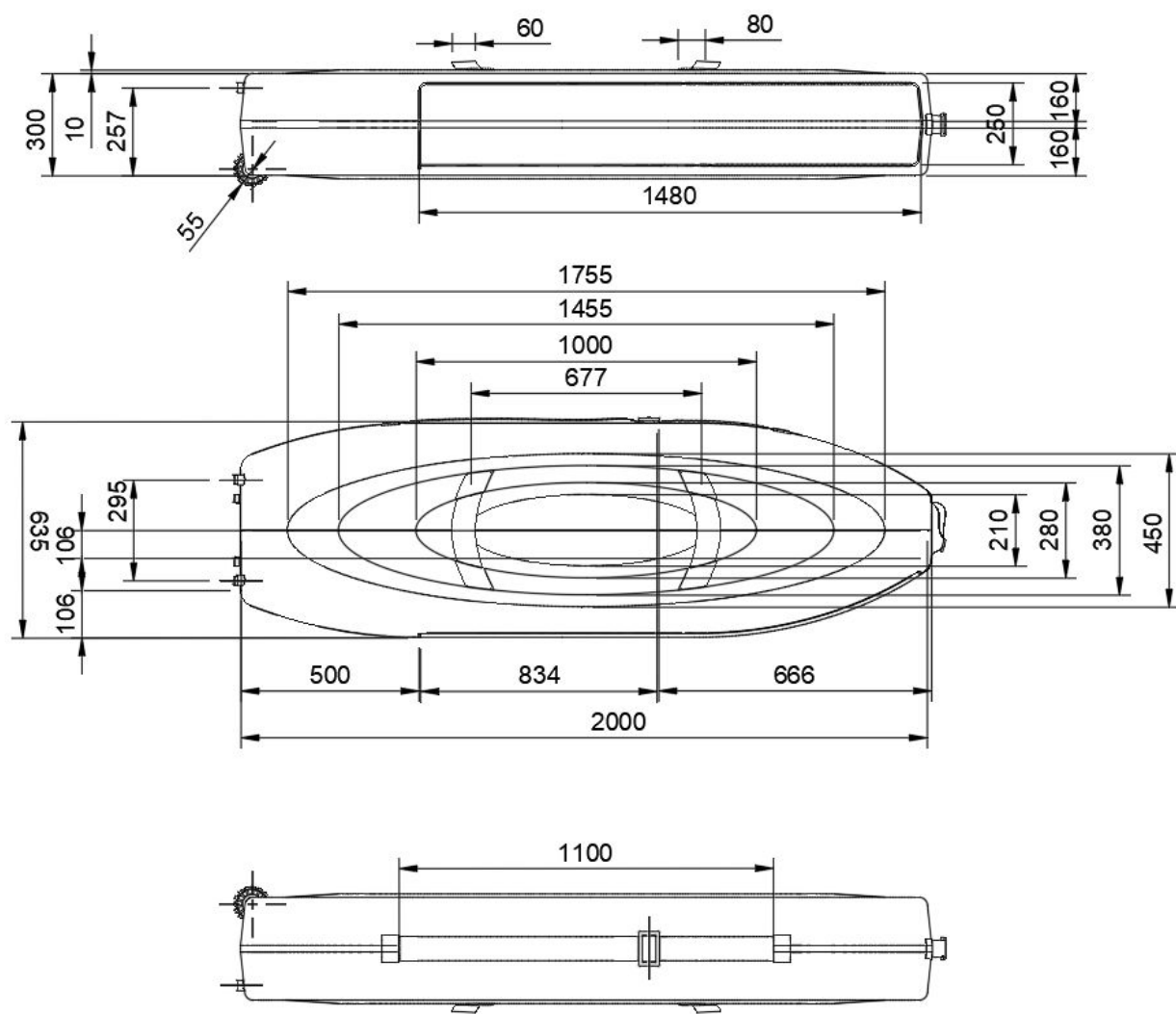
Adhesion point





DIMENSIONS

TECHNICAL DRAWING

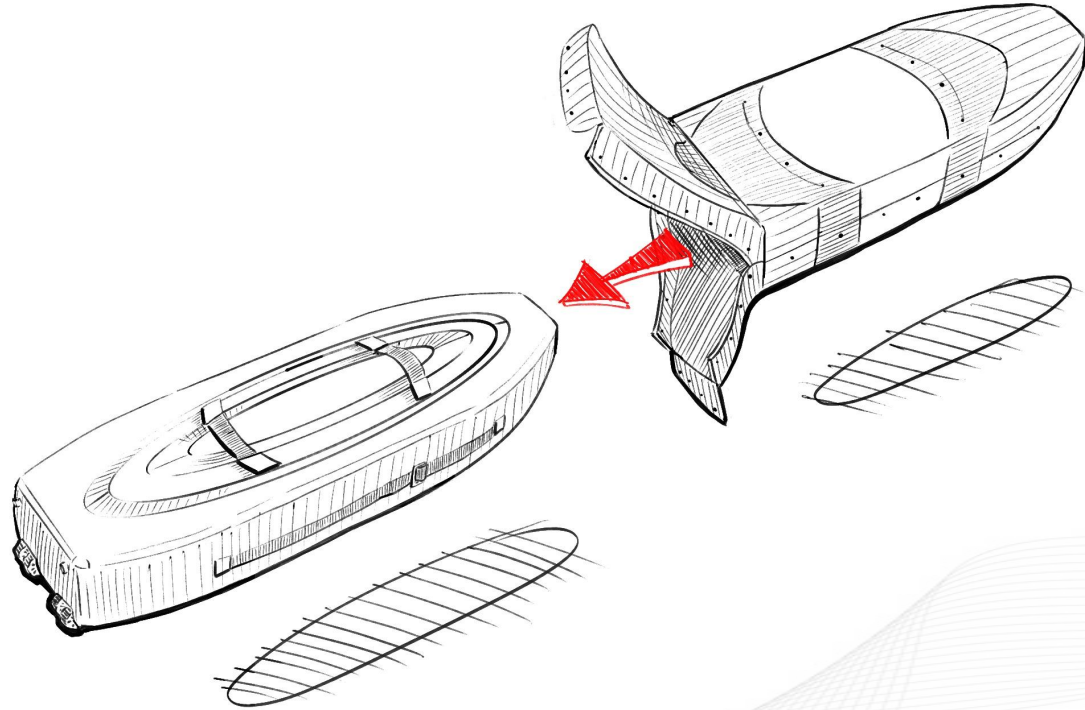


DETAILS

FABRIC COVER

Nylon Cordura 600D
YKK zippers

To protect the plastic case and for personalization there is the choice to put a fabric cover around the plastic case, as shown in the sketch.

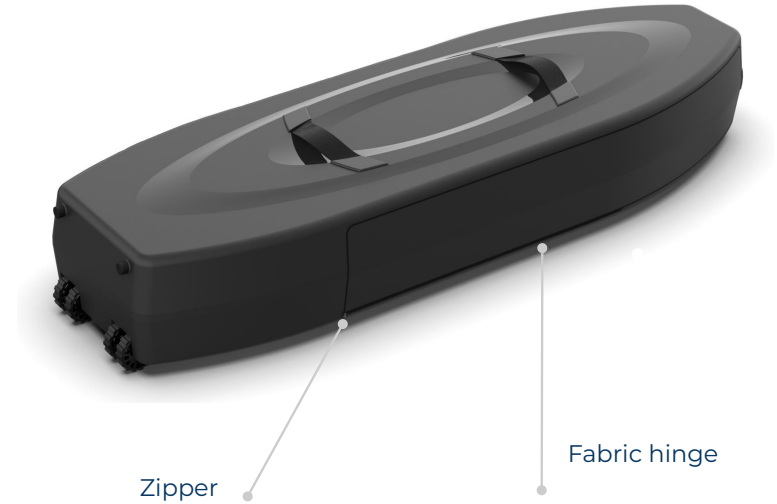
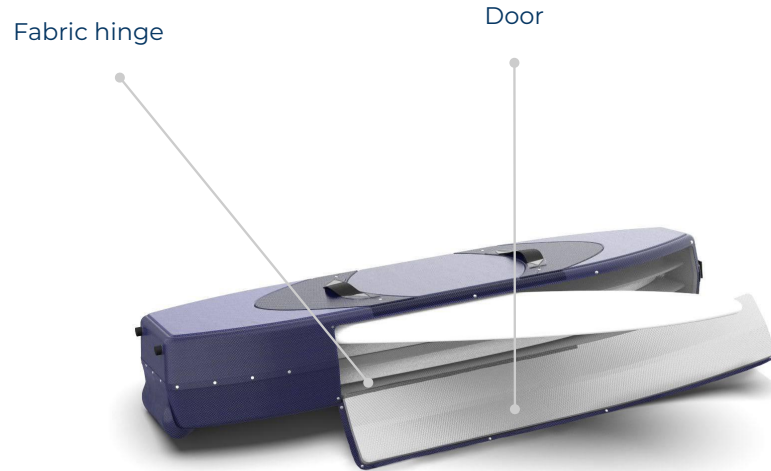


IN CONTEXT COLORWAY COMPARISON



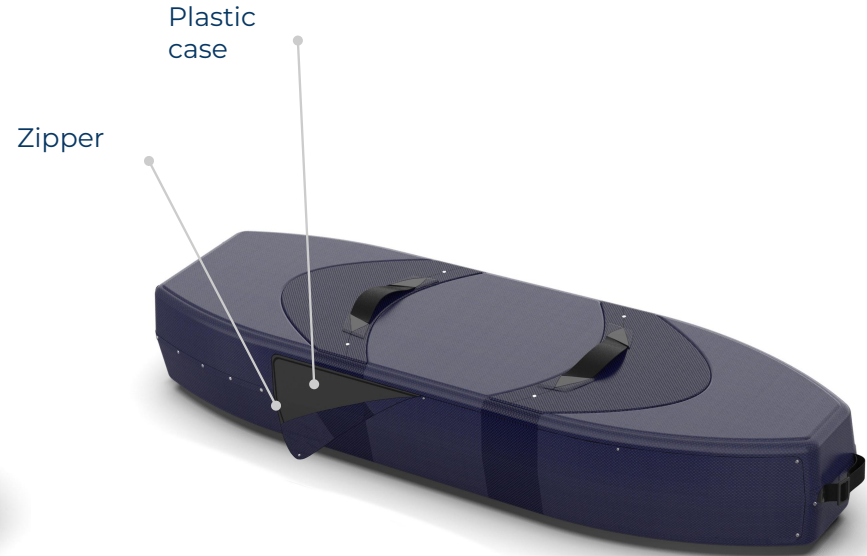
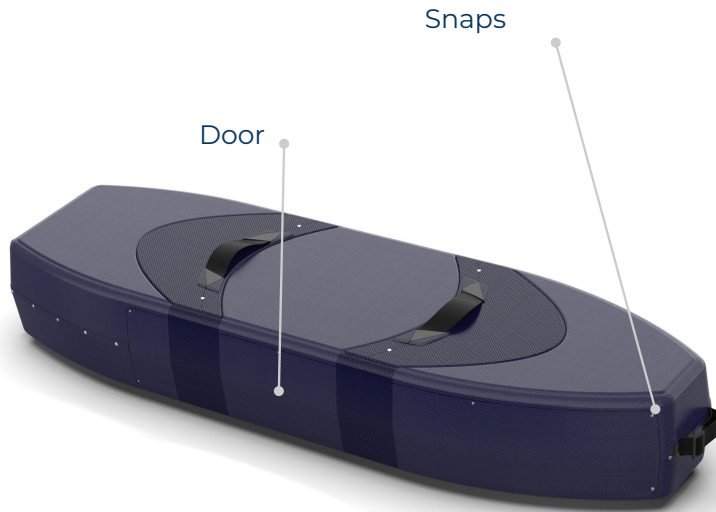
ZIPPER AND HINGE

The door is secured with a fabric hinge attached to the straight part of the case.



ZIPPER AND HINGE

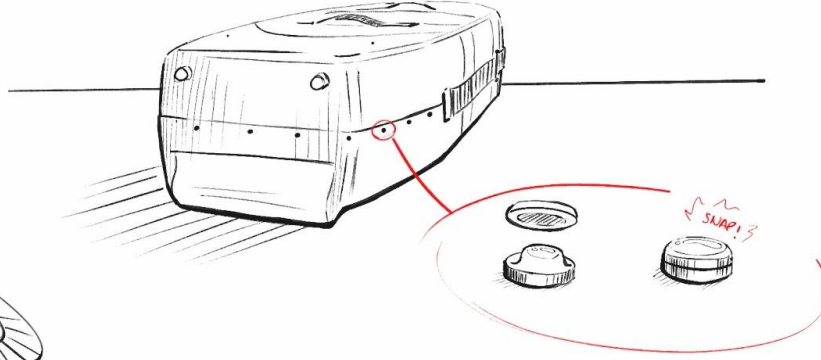
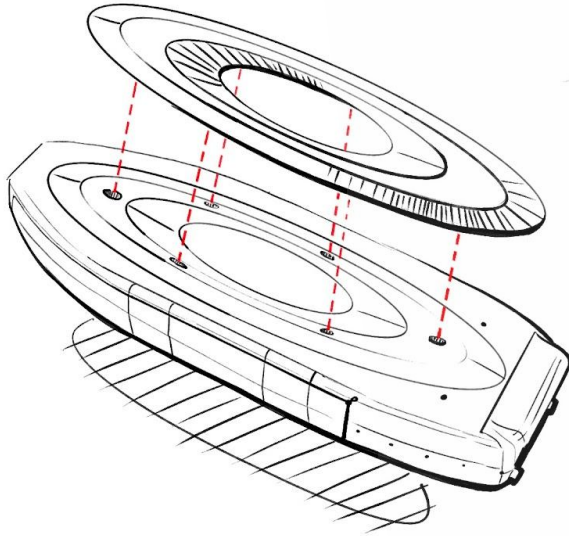
The fabric cover closes around the door with small snaps, for easy and quick access to the door.



SECURING FABRIC COVER

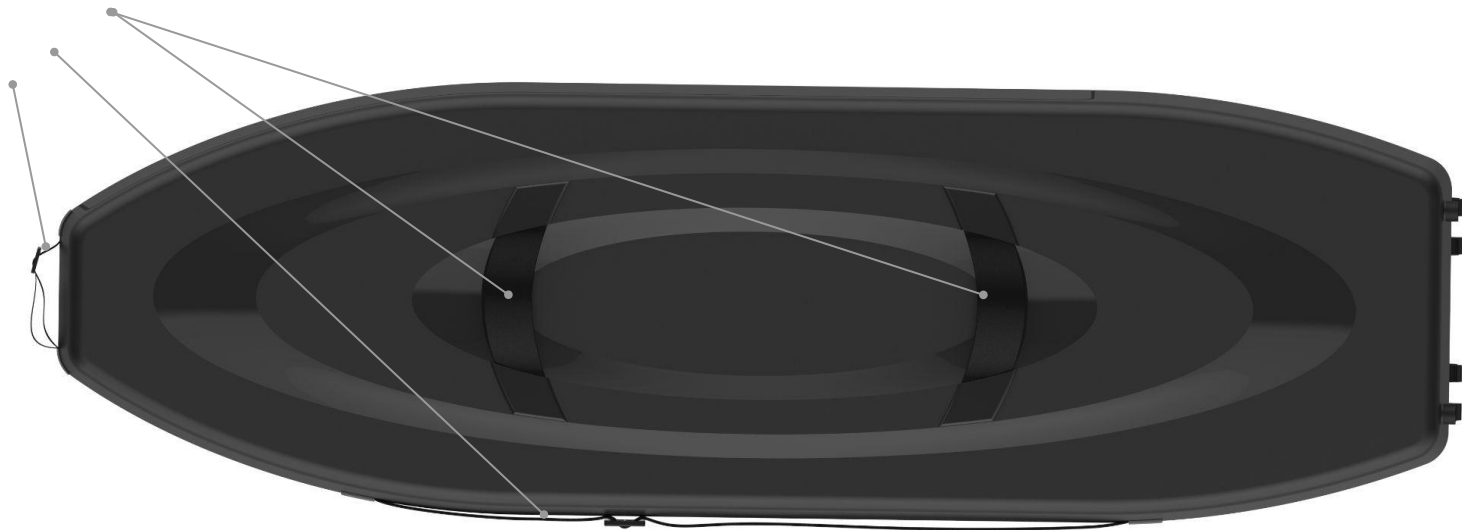
Non corrosive metal

Snaps along the open bottom.
Elliptical rubber foot is removed to be
attached on top afterwards.



HANDLES

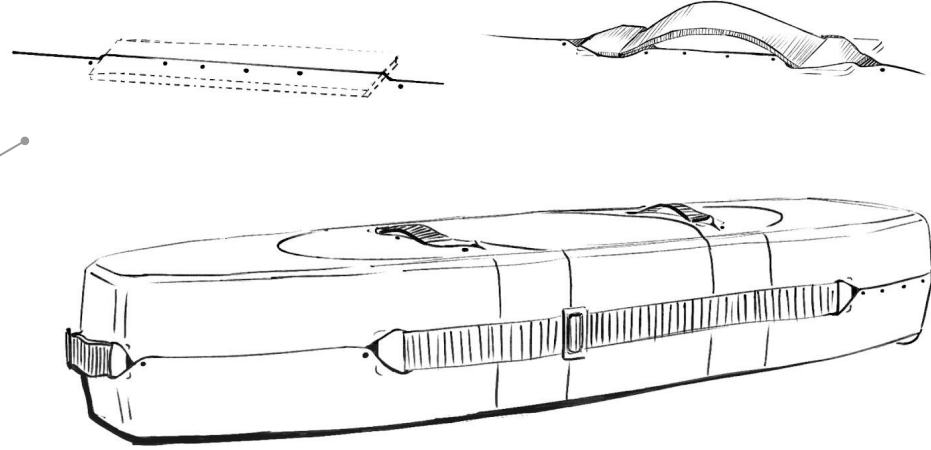
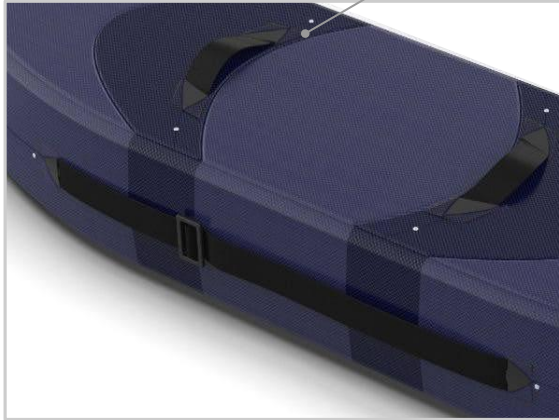
Nylon Cordura 900D
Inside padded



HANDLES

Snaps along where the handles are supposed to go.

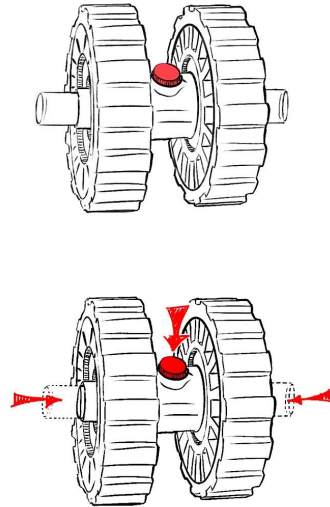
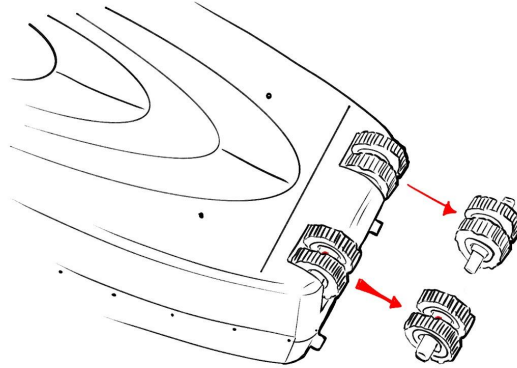
Opened to take the handle out and then close around the fixation points of the handles.



WHEELS

Removable.
First breaking areas, easily replaced.

To remove press the red button and the pins on each side go in and the wheels can be taken out.

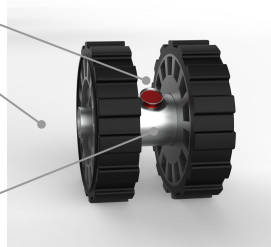
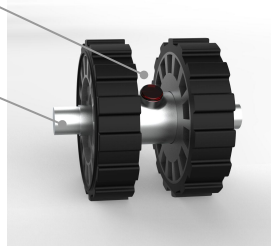


WHEELS

Red button
Non corrosive metal pins

While the button is pushed down, the pins get pulled in and the wheels can be removed

Non corrosive metal bearings



Aluminum reinforcement plate

Non corrosive metal pins

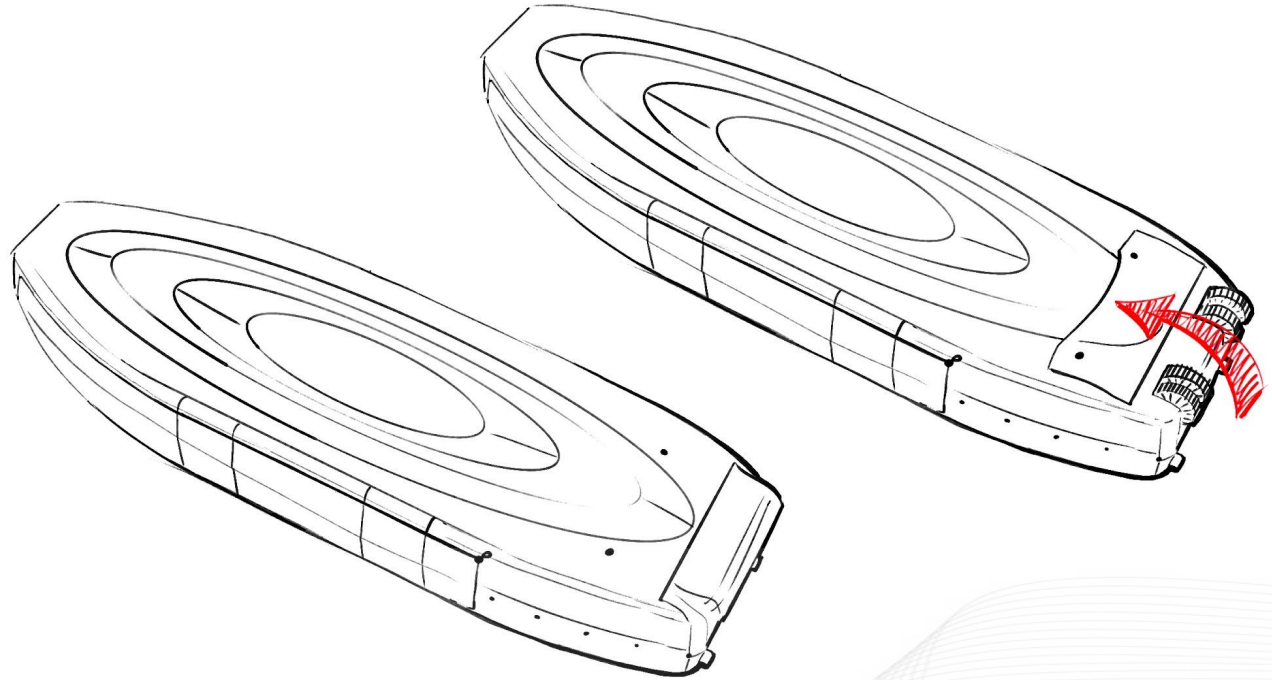


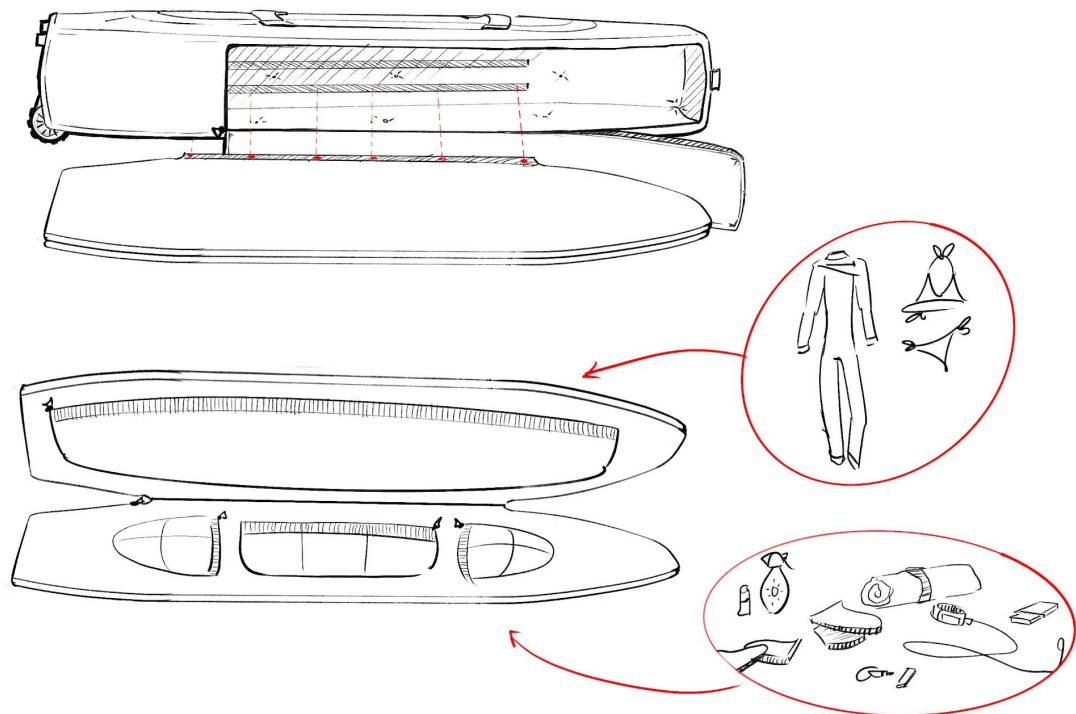
Textured polyurethane outer shell

PP structure

WHEEL FABRIC COVER

The wheels are furthermore protected by the fabric cover, which can be pulled up and attached to the bottom part when the wheels need to be exposed.





FOAM INSERTS

*Tarpaulin
Inside padded
YKK zippers*



Personalizing

*Patches for fabric/
stickers for plastic*



Repairable

Design for disassembly



**Attachment+functionality
= take care**

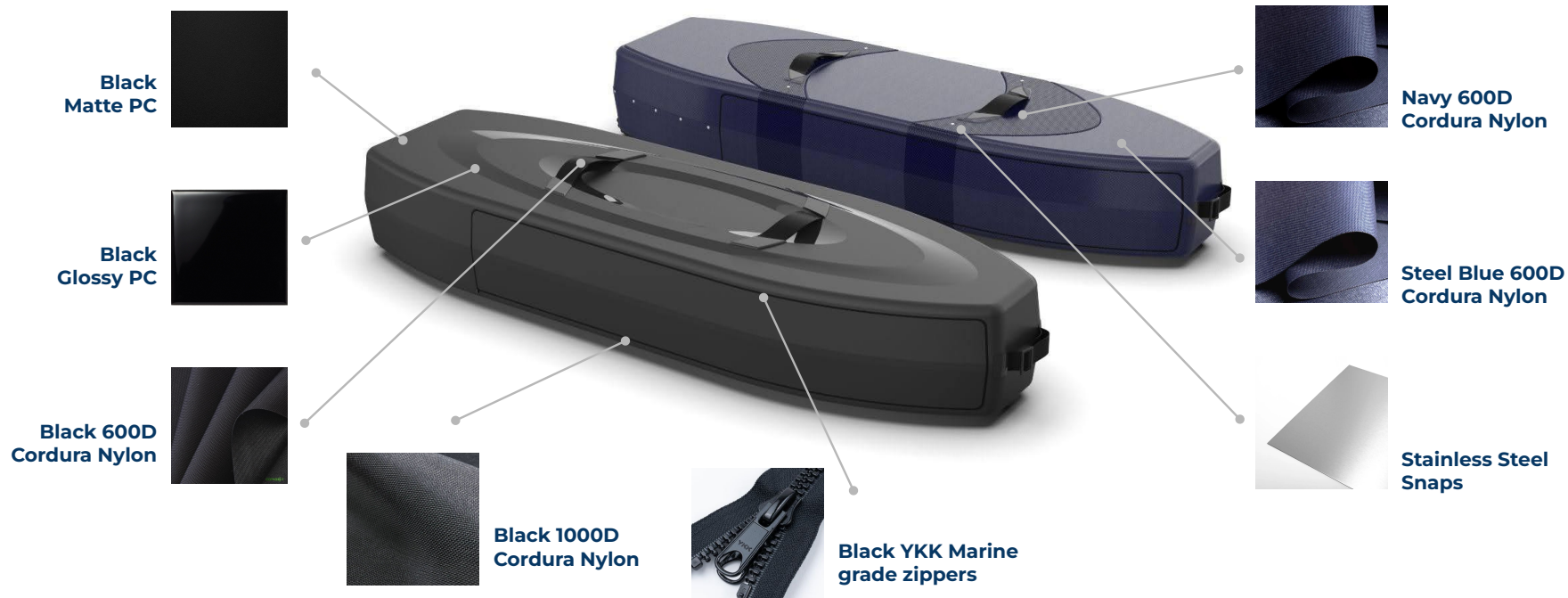


CMF

Plastic case

CMF

Fabric cover



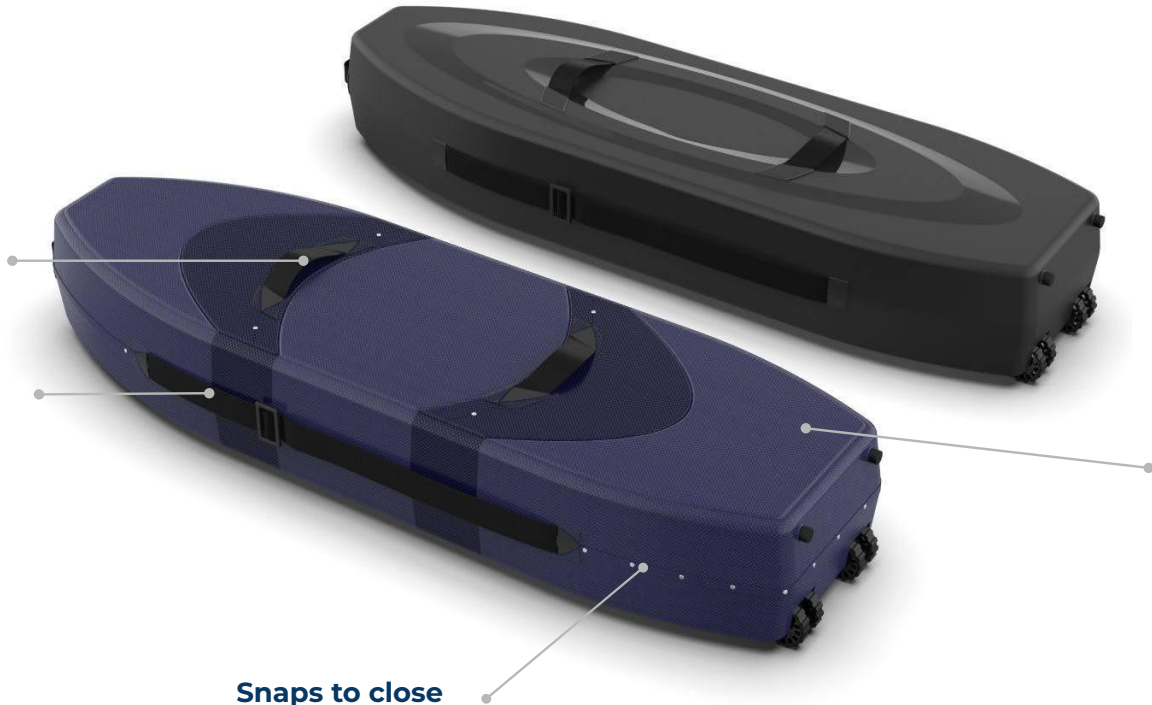
FINAL PRODUCT

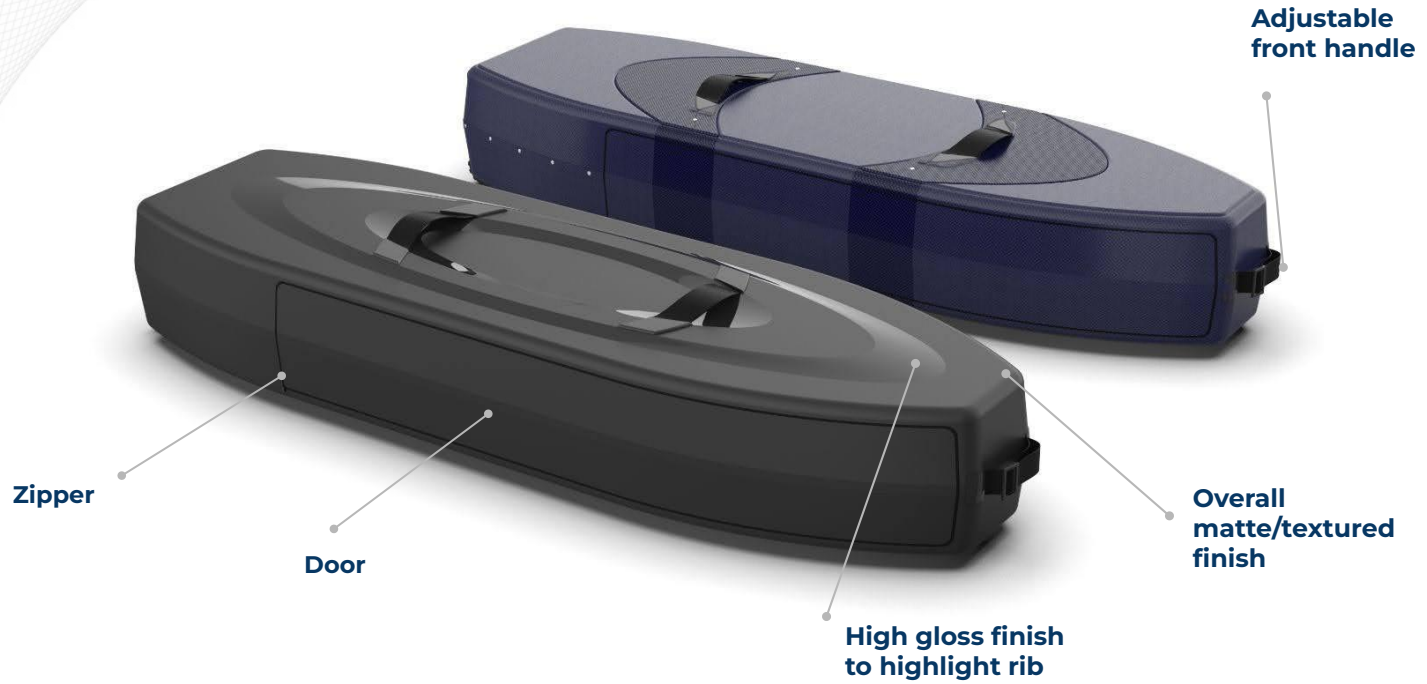
**Short top
handles**

**Adjustable
side handle**

**Snaps to close
fabric cover**

Fabric cover





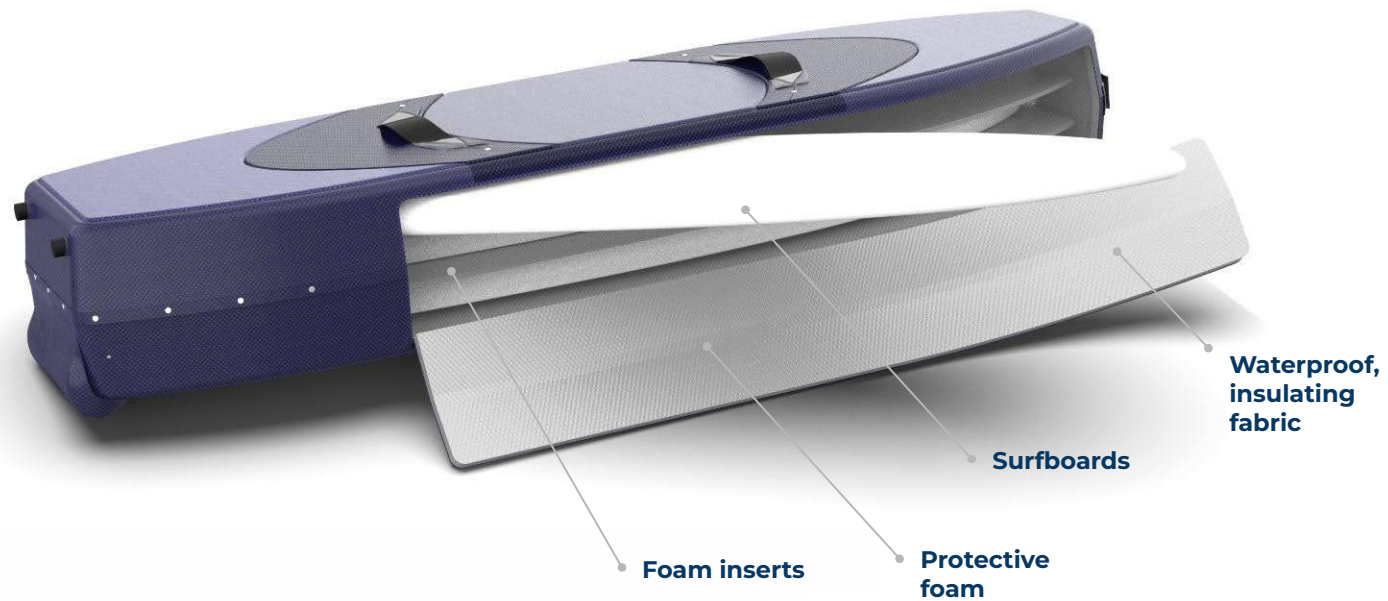


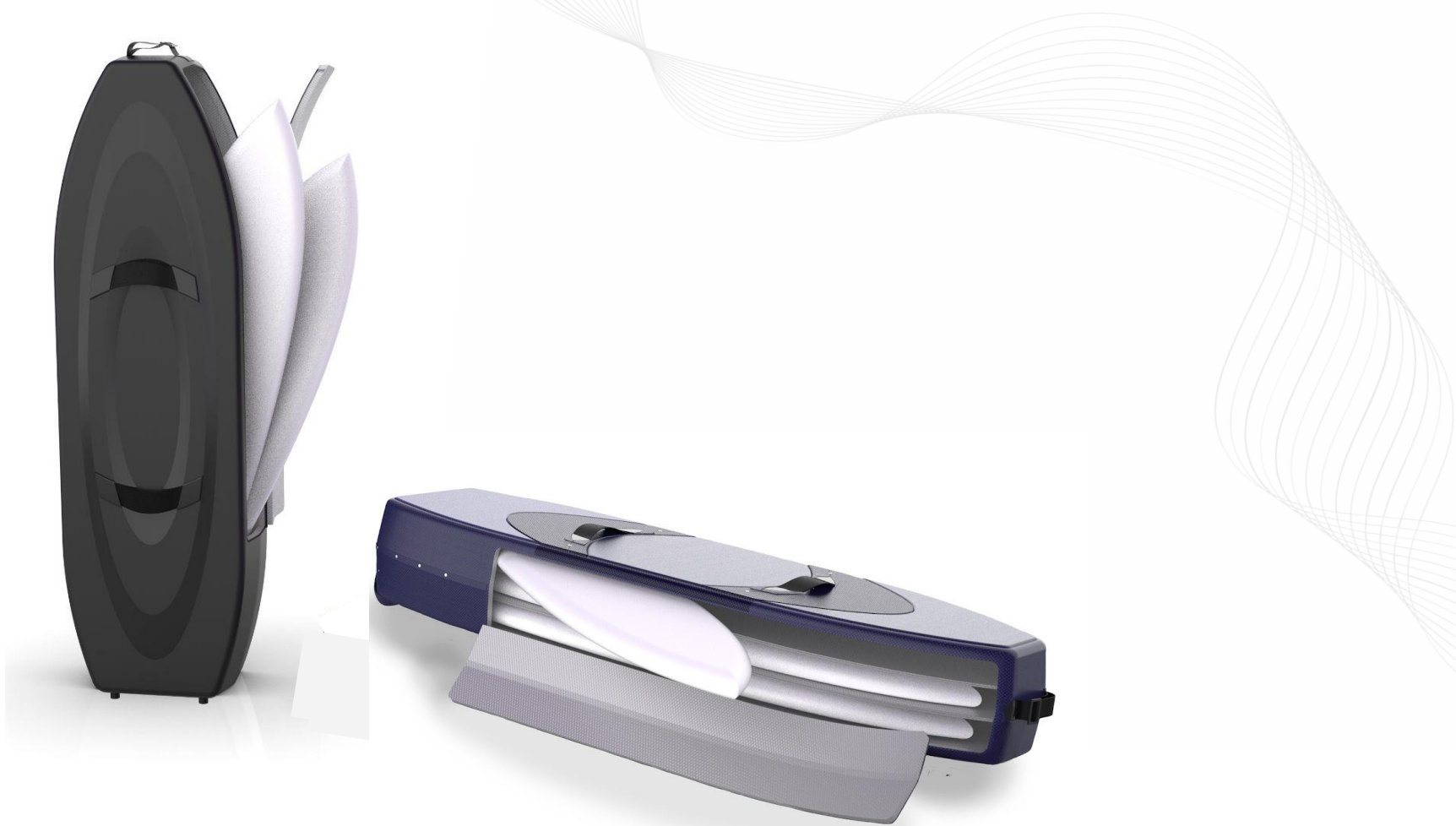
**Removable
rubber "foot"**

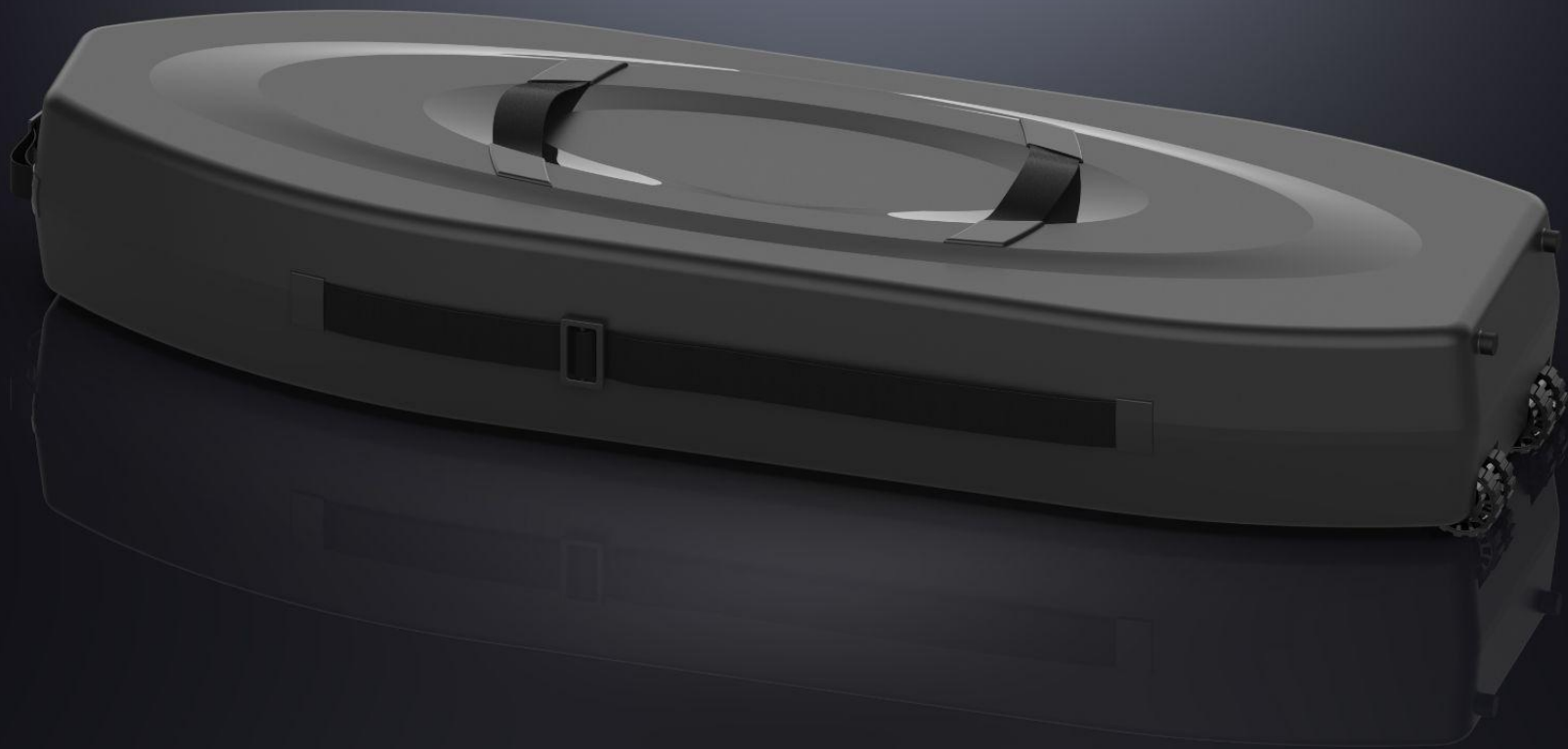
**Wheel fabric
cover**

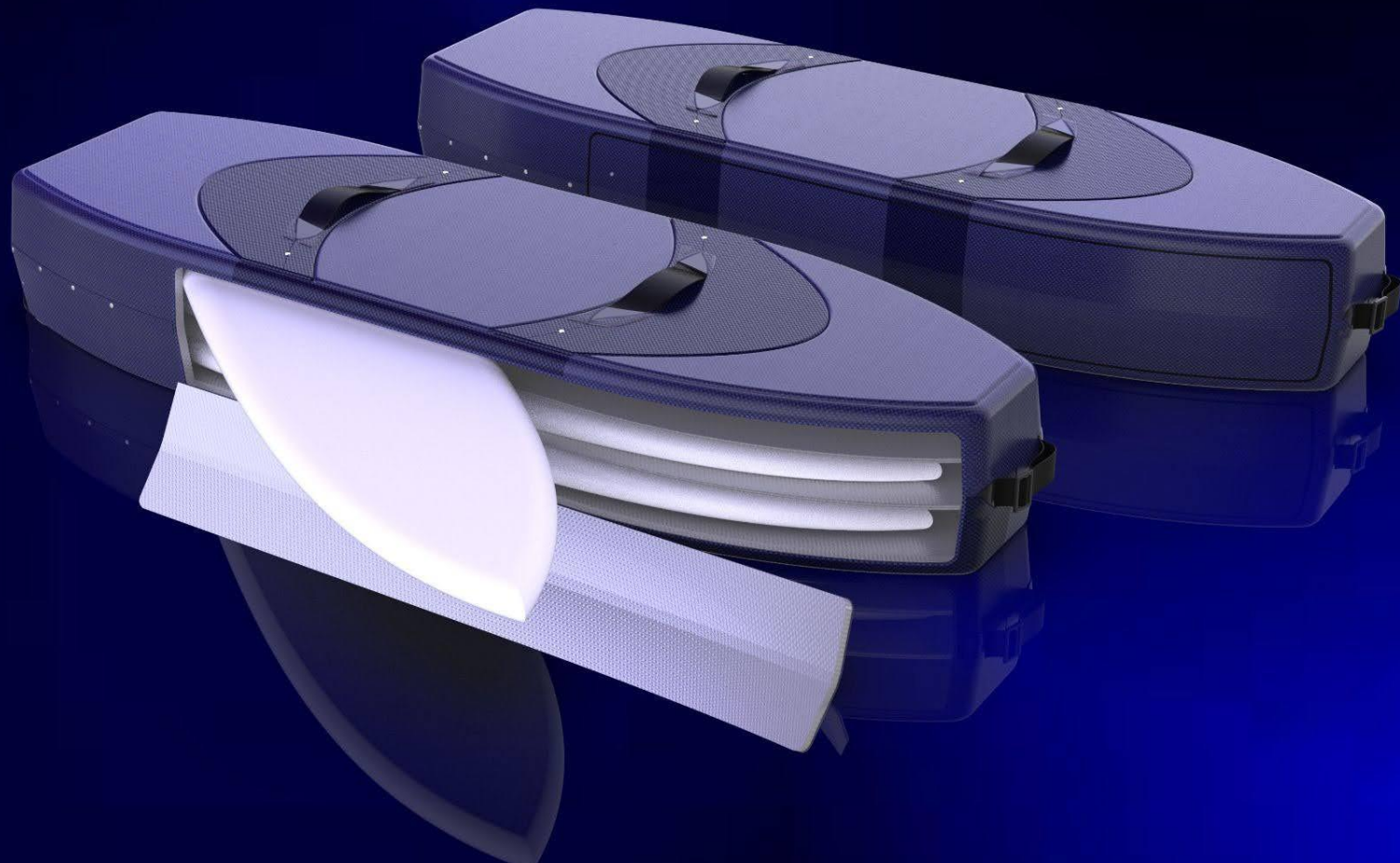
**Removable
wheels**

Rubber feet









THE TRIP















Thank you!

REFERENCES

Texas bag handling ergonomics
<https://www.tdi.texas.gov/pubs/videoresource/essibaggagehand.pdf>

Material comparison done with ChatGPT, compared with Gemini Pro 's analysis and further scrutinized by both a professional in the field and myself. Also compared to products in the market: Veia, Ocean and Earth, Prolite, Db Journey.

Shortboard dimensions from Tablas Surf Shop.

Airline restrictions
<https://www.boardshop.co.uk/blog/surfboard-airline-fees/?srsltid=AfmBOor0Cni5V5vnemiEZolJkml3lpZW-KLOz57OGFpG3GSSK5IIUFKM>
<https://freewavesurfacademy.co.uk/airline-surfboard-fees/>

Background and motivation research from news articles as shown in the pictures and social media, TikTok, Facebook and Instagram.