Appendix

Table of contents

Appendix A. Component calculations

A furniture panel from CoffeeBased is 1.22 by 2.44 m. This gives it a planar surface area of 3 square meters. All components except for the core are used twice, making up 6 square meters of material. As the area is constant for all components, the thickness is used to calculate the percentages.

Total furniture panel: 1.22m x 2.44m = 3m2.
Laminate: 2 layers = 6m2
Coating: 2 layers = 6m2
Primer: 2 layers = 6m2
Adhesive: 2 layers = 6m2
Core: 1 layer = 3m2

The volume of **coating** needed per m2 laminate is 75-85 mL on average, according to Biohome (n.d.).
450-510 mL coating / panel
2 panels / liter of coating
Density: The coating is said to be 1.034 kg/L.
Price: €111,44 / 2.5L

On average, **adhesive** layers are 0.2 mm thick according to Purk (2017), so: 0.0012 m3 adhesive per panel.
Density: The density of polyurethane is 1200 kg/m3 according to the CES Edupack (2019).
Price: The adhesive used is sold for €13 per 0.26 kg. The total weight is 1.4kg and therefore 5.5 times the sold volume is required. This is unlikely, as it would make the adhesive portion of the costs more than €70 per panel. Therefore, it is assumed for the hotmelt, less material is required.

Resysta No Wood

Prices are €358,42 per 25 sheets, excl. transportation and other extra costs.
1. €14,33 per sheet. Sheets are 1.22 times 2.44 m2 and 20mm thick.
Therefore, the panels are €14,33 per 0.0595 m3.
2. €14,33 times (1/0.0595 = 16.8) = €240,84 per m3
3. With a density of 650 kg/m3 the Resysta panels are €240,84 / 650 = €0,37/kg

Plywood

Density: An estimation for the density of 9-ply Poplar multiplex was made using data on 3-5-7 ply Beech plywood (700-800 kg/m3) and the comparison between beech wood and poplar wood (650-830 kg/m3 and 430-530 kg/m3 in that order). Beech wood is about 1.5 times as dense as poplar wood. With this in mind, the density of the 9-ply poplar multiplex is estimated at 500 kg/m3.
Adhesive to ply ratio: The multiplex core consists of 9 plies, each bonded together with a layer of adhesive. To properly calculate the BioBased content, the thickness representative for these 8 layers is separated. The average adhesive thickness is 0.2 mm according to Purk (2017)
Price: A multiplex panel from poplar wood with a thickness of 18mm is sold for €50-€60-€96 (bouwonline.nl, houthandelvangelder.nl, gamma.nl) per panel of 2.5 times 1.22m.

Appendix B. CB2 sample production

SAMPLES

DIY

ORDERED BY THEIR METHOD

01. Chia seeds mix
02. Wall paper adhesive mix
03. Wall paper adhesive mix + pressure
04. Wall paper adhesive mix + clay molds
05. CB2 granulate + table extruder
06. CB2 granulate + table extruder + laundry mangler
07. Mold milling
08. CB2 granulate + oven
09. CB2 granulate + hot press

01. Manufacturing
Chai seeds with coffee

Figure 01.1

Figure 01.2

02. Manufacturing
Wall paper adhesive +
laundry mangler

Figure 02.1

Figure 02.2

Figure 02.3

Figure 02.4

02. Manufacturing
Wall paper adhesive +
laundry mangler +
pressed into shapes

Figure 03.1

Figure 03.2

04. Manufacturing
Wall paper adhesive +
clay molds

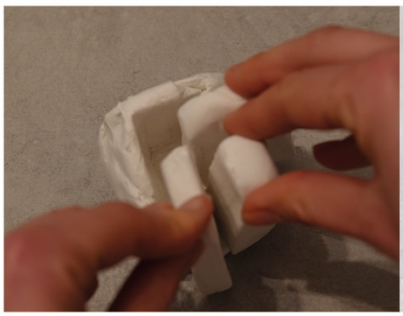


Figure 04.1

04.2C9.2

05. Manufacturing
Extruding CB2 granulate +
clay molds

Figure 05.1

Figure 05.2

Figure 05.3

Figure 05.4

06. Manufacturing
Extruding CB2 granulate +
laundry mangler

Appearance: looks like licorice, some parts are shiny and others matt.

Figure 06.1

Figure 06.2

Figure 06.3

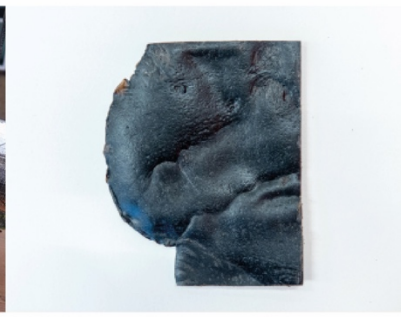


Figure 06.4

Figure 06.5

Figure 06.6

07. Manufacturing
Mold miling

Figure 07.1

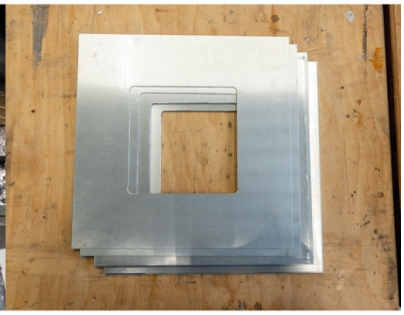


Figure 07.2

08. Manufacturing
Melting CB2 granulate + oven

Figure 08.1

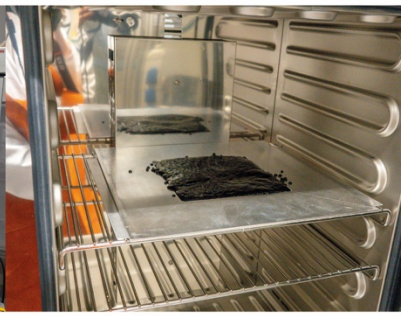


Figure 08.2

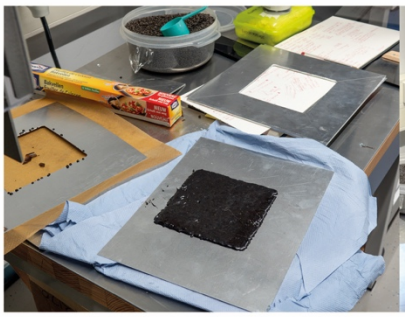


Figure 08.3

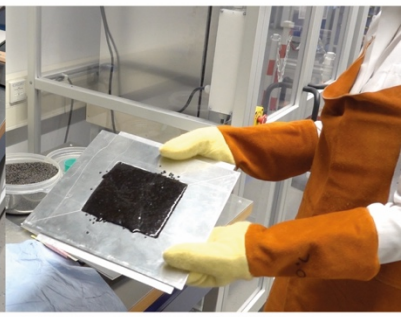


Figure 08.4

Figure 08.5

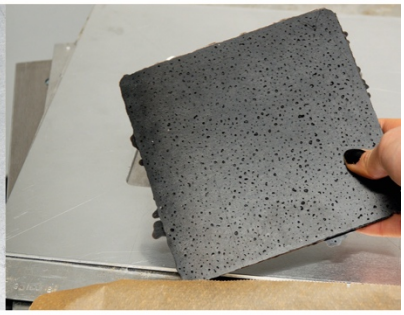


Figure 08.6

Figure 08.7

Figure 08.8

Figure 08.9

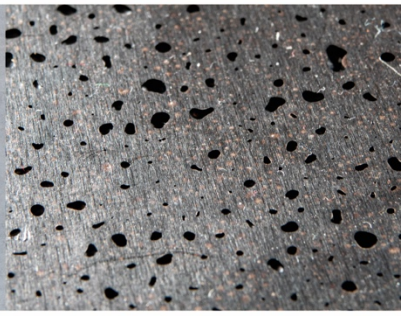


Figure 08.10

09. Manufacturing
Melting CB2 granulate + hot press

Figure 09.1

Figure 09.2

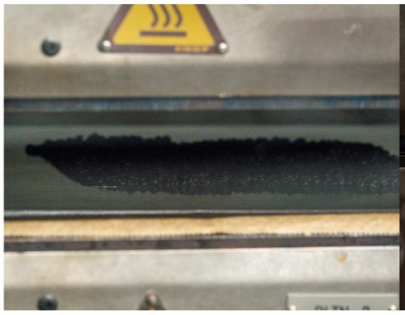


Figure 09.3

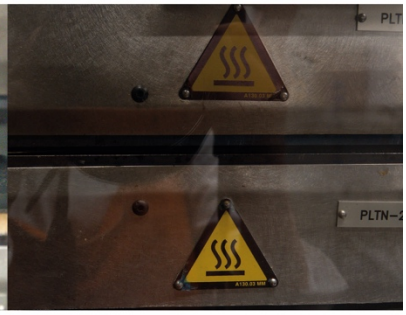


Figure 09.4

Figure 09.5

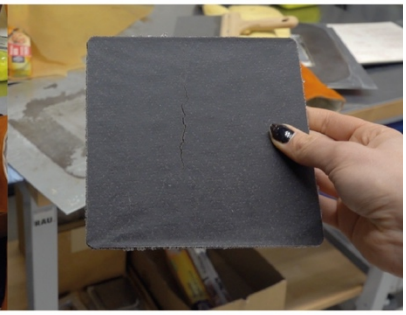


Figure 09.6

Figure 09.7

Figure 09.8

Figure 09.9

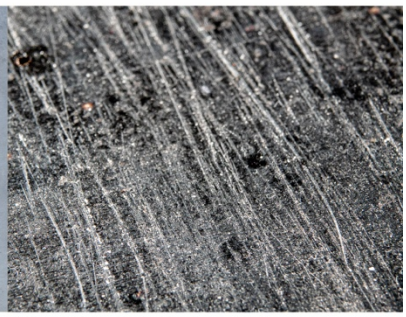
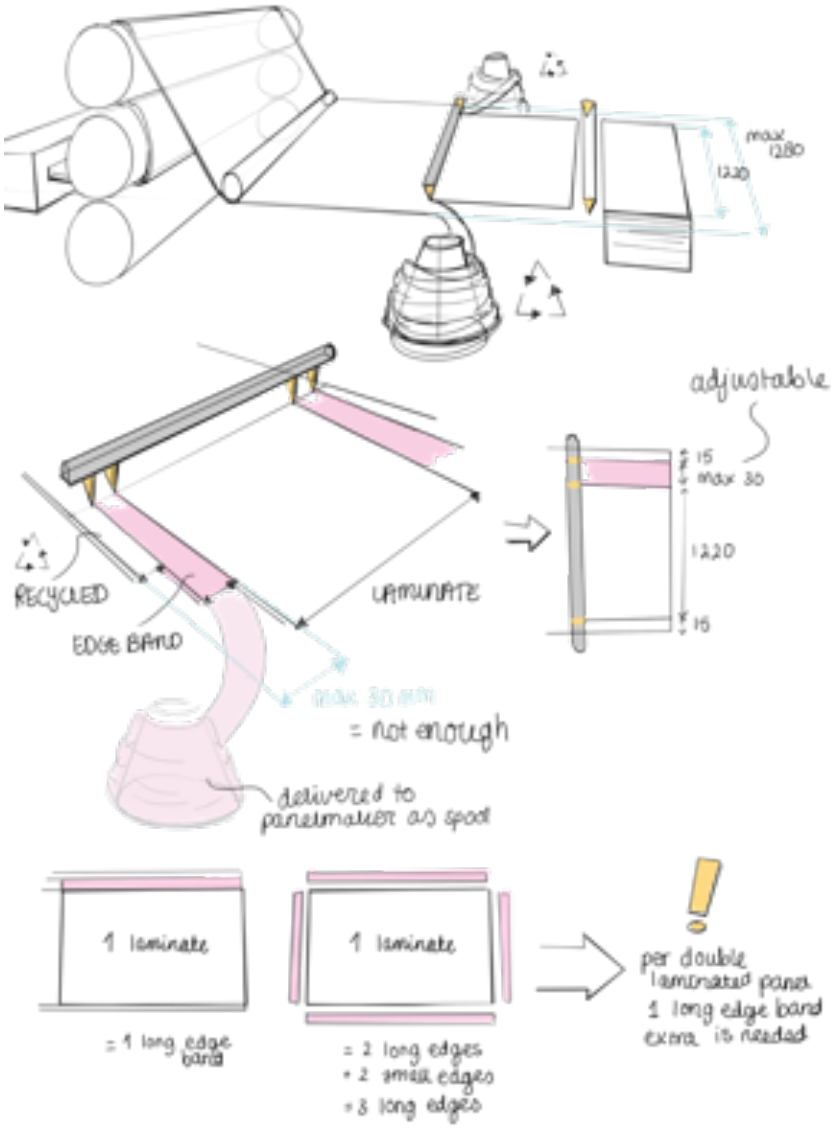


Figure 09.10

Appendix C. Edge band production

It is best to produce edge bands that have a thickness of 1 to 2 mm thick. This makes it impossible to slice strokes during the production of the current CB laminate (0.8 mm thick), that would qualify as edge band. The extruder will need to be adjusted to produce a thicker laminate. The desired width of the edge band is 2mm thicker than the thickness of the furniture panel. For example, an 18mm thick panel would require the laminate cutter to cut every 20 mm. Or else, 60 knives would need to be added to divide the 1220mm wide laminate into 61 parallel strokes. Advantage of the latter option is the possibility to store the edge band by rolling it up, whereas the first option would result in surface scars in panels longer than 1220mm.



Appendix D. Condiment organizer calculations

The deflection caused by insufficient mechanical properties depend on the applied force, Young's Modulus, width, thickness and length of the panels.

If the applied force for furniture panels is a coffee machine from MAAS, it is exposed to a force of 1000N. If the situation the condiment organizer will be exposed to is about 10 times as small, the thickness can be 2.15 times as small if the material remains unchanged. Therefore, a multiplex core with a thickness between 8.4mm and 9.3mm will suffice. Due to availability, both 8 and 9mm can be considered.

8mm + both side laminated = 10mm
9mm + 1 side laminated = 10mm

A thinner version
The furniture panel is equipped to deal with larger forces than the condiment organizer will have to deal with. Therefore, it does not require a core layer as thick as the furniture panel has now. It is assumed that a thickness of 4 mm will be enough for this product.

F1: Use furniture panel for the condiment organizer: with 20% of its thickness.

SCG content

Weight of CB1 [g] / 35 = amount of saved SCG [per coffee cup's worth]
Weight of CB2 [g] / 47 = amount of saved SCG [per coffee cup's worth]

Density * Volume = Weight
Density_CB1 [kg/m3]: 1300
Density_CB2 [kg/m3]: 955
Volume_laminates [m3]: 0.8 e-3 [m] * area [m2]

Coffee weight cups

CB1: (1300 * 0.8e-3 * 1 [m2]) / 0.035 = 30 cups of coffee per m2
CB2: (955 * 0.8e-3 * 1 [m2]) / 0.047 = 16 cups of coffee per m2

*For CB panels laminates on both sides, volume needs to be doubled. *

One cup of coffee on average takes 7 grams of grinded coffee beans to generate. After the coffee is brewed, in which water is added, about 17.5 grams of SCG remains. The dehydration process reduces this weight to about 7 grams of SCG usable in the BioComposite mixture. There is a volumetric percentage of 20% of SCG in the CB1 mixture, resulting in the need for 35g of CB1 material to harness 1 coffee cup's worth of SCG. For the CB2 material, with its reduced 15%, it takes 47g of CB2 material to achieve the same.

0,05238 m3 agricultural waste
Density = 720 kg/m3

The required area of CB panel for the production of the Kovivol is 1.22 [m] times 0.6 [m] takes up an area of 0.73 m2, saving approximately:
- laminated on 1 side, CB1: 22 cups worth of SCG
- laminated on 2 sides, CB1: 44 cups worth of SCG
- laminated on 1 side, CB2: 12 cups worth of SCG
- laminated on 2 sides, CB2: 23 cups worth of SCG

Appendix E. Material tests

RESULTS

TEST

ORDERED BY THEIR PURPOSE

A. Material properties
B. Surface modification
C. Shape modification
D. Attachment methods
E. Adhesives (incl. BioImpact)
F. Coatings (incl. BioPin)
G. Cores (incl. Resysta NoWood)

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A1. Material properties - density
Pieces of LDPE, HDPE and CB1 are put into a glass of water. The LDPE floats on top (0.92g/cm3) and HDPE just underneath (0.96 g/cm3) (figure A1.1). CB1 sunk to the bottom straight away (1.2 g/cm3) (figure A1.2). Makes sense as the density of water is 1 g/cm3.

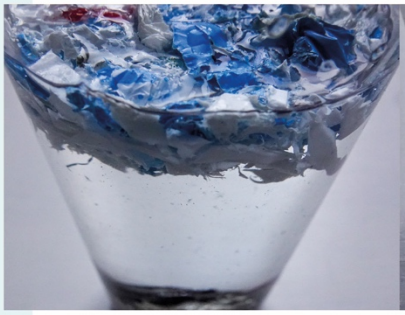


Figure A1.1

Figure A1.2

A2. Material properties - flame
A method to determine the type of plastic is to light it on fire. The following characteristics are indicators: the color of the flame (figure A2.1) the duration the material stays lit and the appearance of the material afterwards (figure A2.2). For the CB1 material this indicates: XXXX

Figure A2.1

Figure A2.2

A3. Material properties - water + soap

Figure A3.1

Figure A3.2

A4. Material properties - UV resistance

The exposure to UV radiation has led to discoloration (figure A4.1) and distortion (figure A4.2) over time.

Figure A4.1

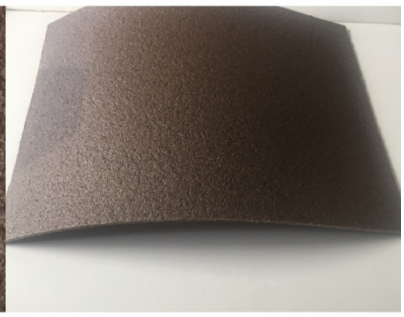


Figure A4.2

A5. Material properties - Scratch resistance

The scratch test was used to mimic sharp objects that negatively impact the surface of the furniture panel (figure A5.1). The scratches between the pink and yellow cirkles are made using the scratch test, with and without a brick respectively. The blue cirkles point out a scratch made by a more blunt object (figure A5.2).

Figure A5.1

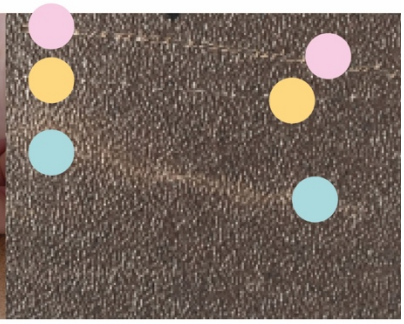


Figure A5.2

A6. Material properties - Plastic Scanner results

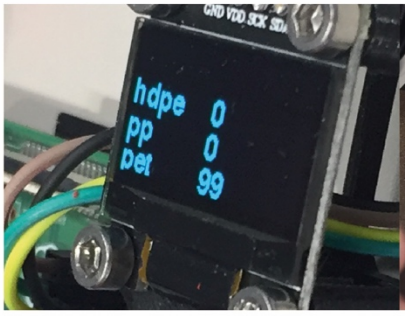


Figure A6.1

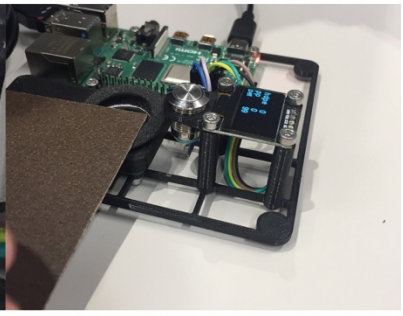


Figure A6.2

A7. Material properties - Wetting angle

oil droplet 7.1
water droplet 7.2

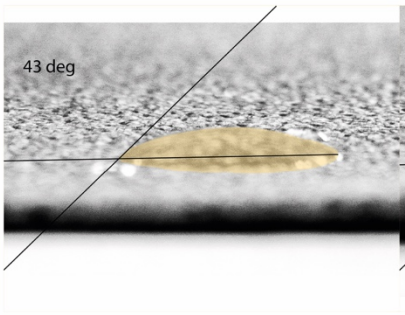


Figure A7.1

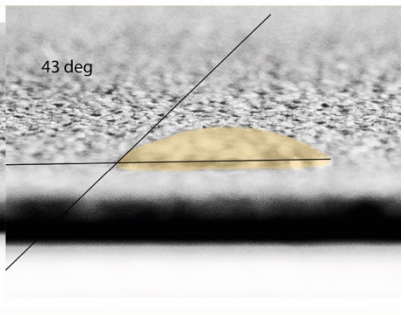


Figure A7.2

A8. Material properties
Coffee machine setup

Set up

Figure A8.1

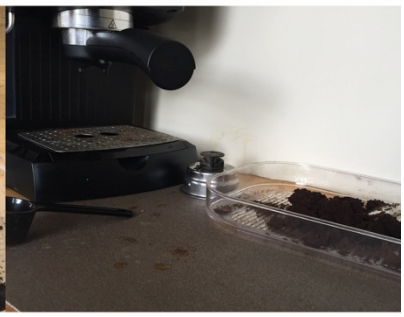


Figure A8.2

A9. Material properties
Coffee machine setup

Discoloration

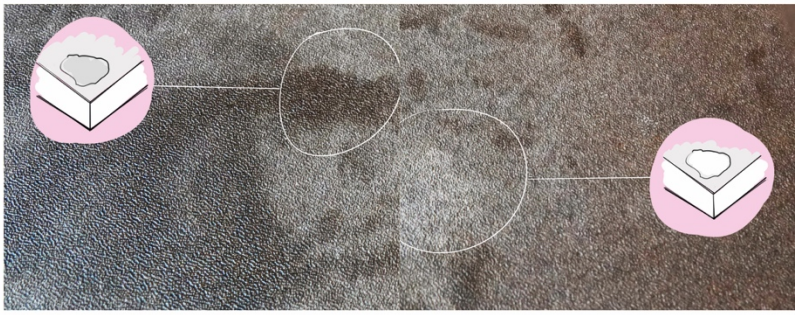


Figure A9.1

Figure A9.2

A10. Material properties
Coffee machine setup

Distortion

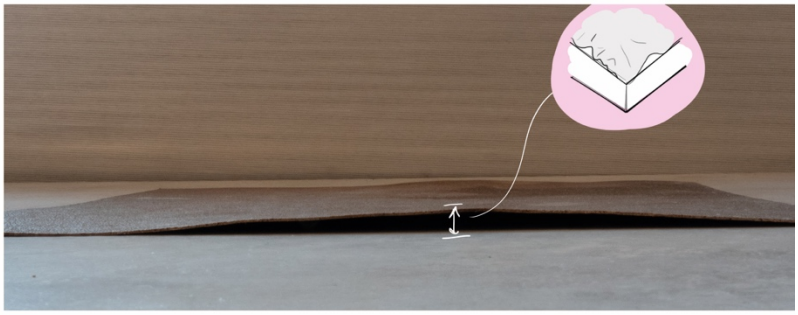


Figure A10.1

Figure A10.2

A11. Material properties
Dishwasher impact

A partially coated piece of CB1 laminate was put into the dishwasher. The caused discoloration and distortion (figure A3.1) is less intense in the areas that are coated (fossil-based lacquer) (figure A3.2).

Figure A11.1

Figure A11.2

A1. Material properties - CB2 oven sample

oil droplet 1.1
water droplet 1.2

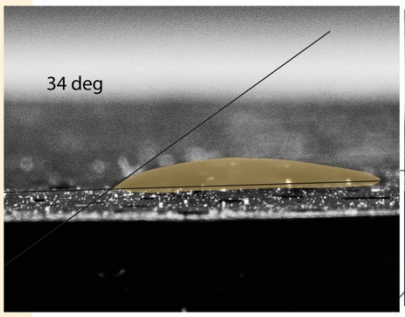


Figure A1.1

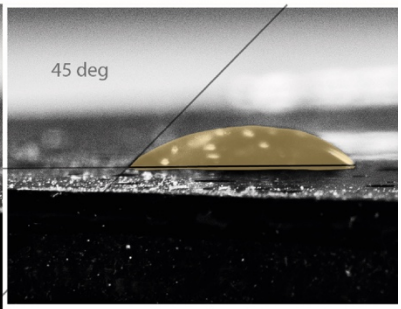


Figure A1.2

A2. Material properties - CB2 hot press sample

oil droplet 2.1
water droplet 2.2

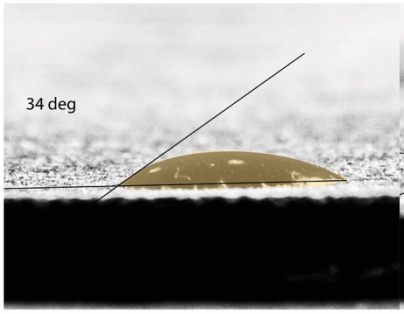


Figure A2.1

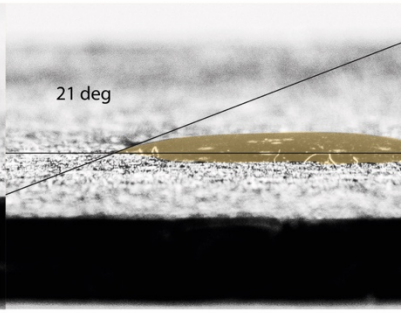


Figure A2.2

A3. Material properties - White dust appearing on CB2

before 3.1
after removing it 3.2

Figure A3.1

Figure A3.2

A4. Material properties - Scratch impact

oven 4.1
hot press 4.2

between pink = + brick
between yellow = normal

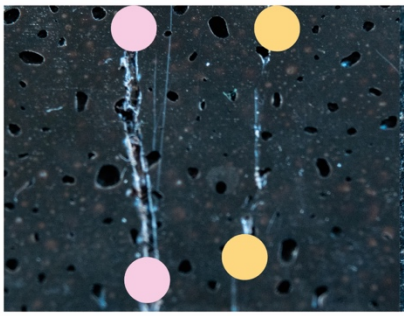


Figure A4.1

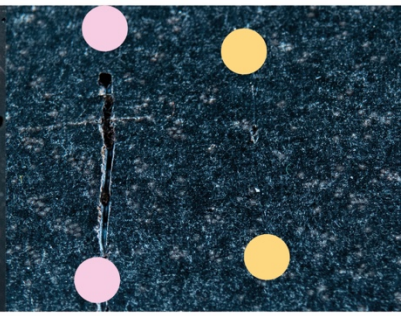


Figure A4.2

B1. Surface modification - sand blast

The sandblast machine can be used to discolor the CB1 material on purpose. By covering certain parts of the material, patterns and structures can be made. Regular tape did not stay put during the process (figure B1.1.). Ducttape did manage to stay adhered to the CB1 laminate during the sandblasting (figure B1.2).

Figure B1.1

Figure B1.2

B2. Surface modification - thermoplastic behavior

Pressing hot objects into the CB1 laminate melts the material on that specific spot. The reshaped material can advertise a signiture look, logo's or even statements if only the stamp is elaborate enough. XXX Also a heated button was used (figure 7.2).

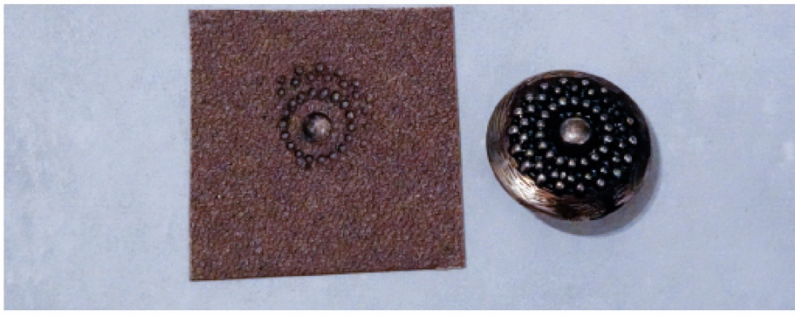


Figure B2.1

B3. Surface modification - chemical discoloration

The discoloration that occurs after exposure to certain liquids can also be used as advantage. A mixture of natural materials, maizena and jodium, was used to paint the CB1 laminate darker (figure B3.1)

B3.2 Tea

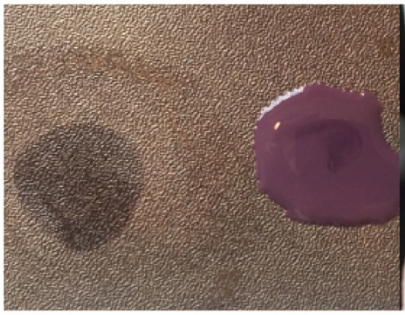


Figure B3.1

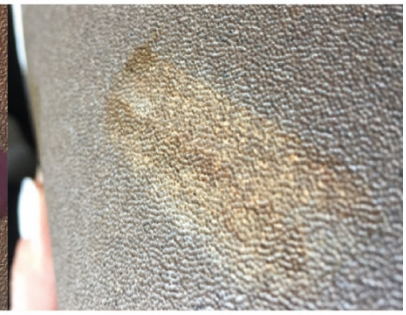


Figure B3.2

B4. Surface modification - laser cut
The machine and settings

Plastic Acrylic 0.5mm
"It's not an easy material to cut with the laser" (PMB employee).

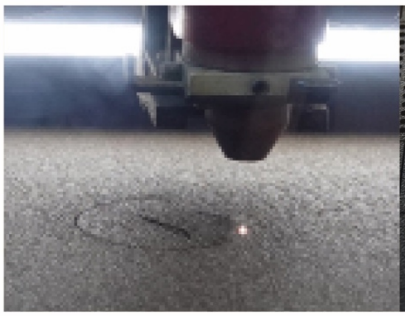


Figure B4.1

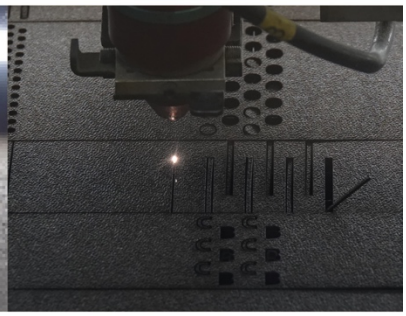


Figure B4.2

B5. Surface modification -
- laser cut
Logo's

B5.1

B5.2

Figure B5.1

Figure B5.2

B6. Surface modification -
- laser cut
Engravements
Full engravements (figure B6,1)
Line engravements used in the final prototype (figure B6.2)

Figure B6.1

Figure B6.2

B1. Surface modification -
sand blasting

Figure B1.1

Figure B1.2

C1. Shape modification - laser cut
Patterns till the edges

C1.1

C1.2

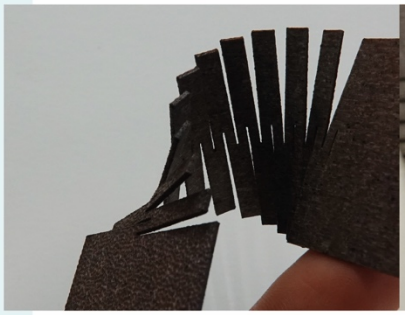


Figure C1.1

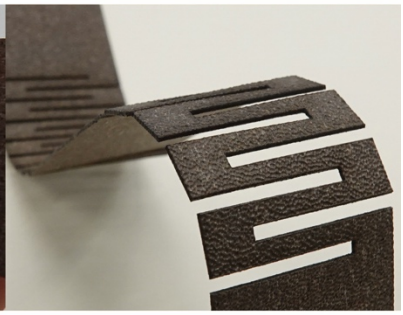


Figure C1.2

C2. Shape modification - laser cut Patterns without reaching the edges

C2.1

C2.2

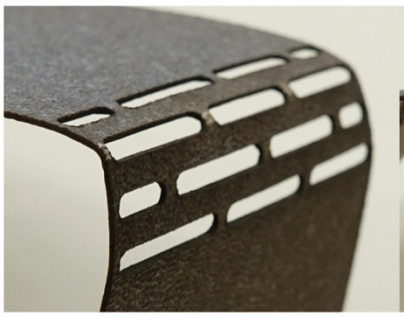


Figure C2.1

Figure C2.2

C3. Shape modification - cold
Without heat to plasticize the material, any reshaping is called cold shaping. This leads to cracks in the CB1 material and discoloration around the bend (C3.1). To get a cleaner bending line, a bending bench commonly used for metals, can be used (figure C3.2).

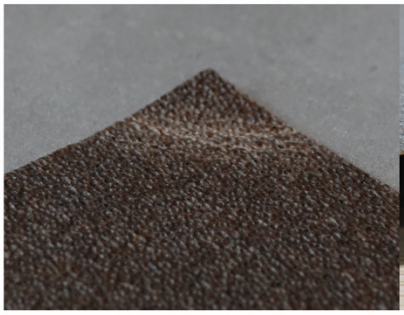


Figure C3.1

Figure C3.2

C5. Shape modification - hot
By hot wire bend machine
As predicted, any bends made whilst the CB1 material is heatened, will not cause discoloration. The material merely melts and cures in the newly obtained shape. This could potentially lead to loss of the surface texture. A hot wire machine was used which heats the material locally around the wire (figure C5.1). A mold should have been used if a 90deg angle is desired (figure C5.2)

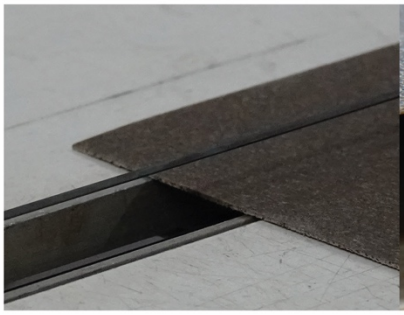


Figure C5.1

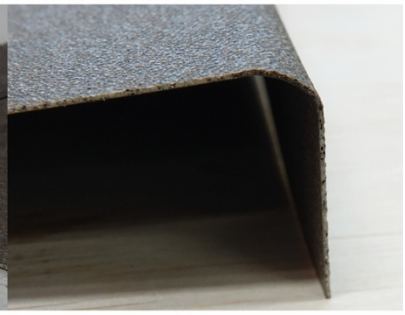


Figure C5.2

C6. Shape modification - hot
By heated beam
Bending around a circular shape

C6.1

C6.2

Figure C6.1

Figure C6.2

C7. Shape modification - hot
By heated wire
Bending around a hot wire, leads to an almost 90deg angle.

C7.1

C7.2

Figure C7.1

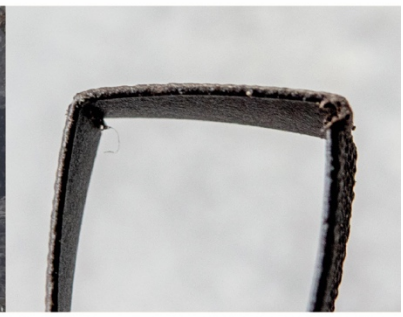


Figure C7.2

C8. Shape modification - hot
By hair straightener
A hot flat surface direct contact

C8.1 direct heat

C8.2

Figure C8.1

Figure C8.2

C9. Shape modification - hot
By melting in a pan

Figure C9.1

Figure C9.2

D1. Attachment methods

x

Figure D1.1

Figure D1.2

D2. Attachment methods
Staples - cold
x

Figure D2.1

Figure D2.2

D1. Attachment methods
Screws

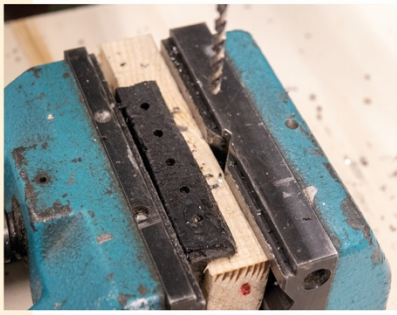


Figure D1.1

Figure D1.2

D2. Attachment methods
Perfect fit

Figure D2.1

Figure D2.2

E1. Adhesives
Woodglue

E1.1 Pressure by hand

E1.2 Pressur with laundry mangler

E1.3 and E1.4 the laundry mangler in use

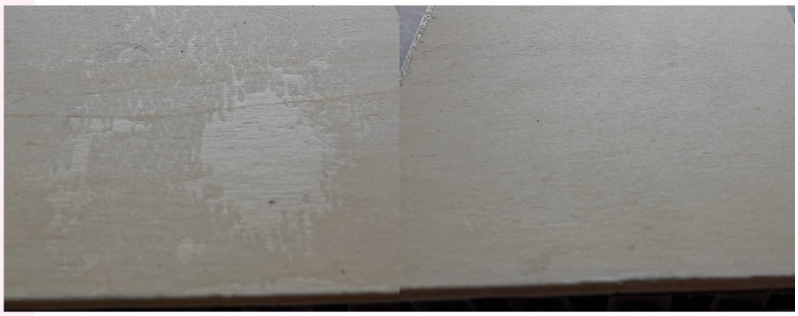


Figure E1.1

Figure E1.2

Figure E1.3

Figure E1.4

E2 Adhesives
Sandblast impact

E2.1 The making of the samples.

E2.3 Before. Left is normal, right is sandblasted.

E2.4 After pulling it off. Left is normal, right is sandblasted.

It is more difficult to pull the wood glued laminate off when it is not sandblasting.

Figure E2.1

Figure E2.2

Figure E2.3

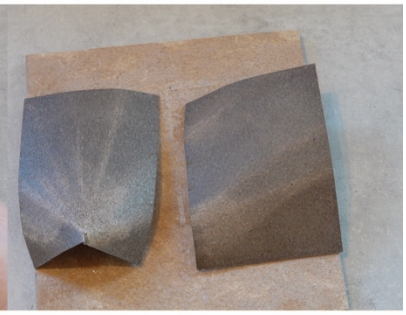


Figure E2.4

E3. Adhesives
Sheet press

Suffient method to apply equal distributed pressure to large panels during curation of the adhesive.

Figure E3.1

Figure E3.2

E4. Adhesives
BioImpact Canect
Dishwasher test

Left is BioImpact, right is wood glue.

E4.1 Before dishwasher test
E4.2 After dishwasher test

Figure E4.1

Figure E4.2

E4.3 The BioImpact adhesive
E4.4 The BioImpact adhesive sprayed on CB1 laminate

Figure E4.3

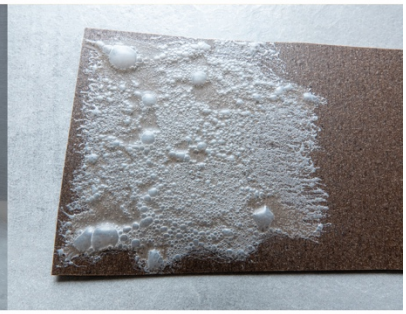


Figure E4.4

F1. Coatings
Traditional fossil-based coatings
Scratch impact

In Dutch:
F1.1 Parket lak
F1.2 Result

F1.3 Blanke lak
F1.4 Result

Figure F1.1

Figure F1.2

Figure F1.3

Figure F1.4

F1.5 Jacht lak
F1.6 Result

Figure F1.5

Figure F1.6

F1.7 Binnenbeits
F1.8 Result

Figure F1.7

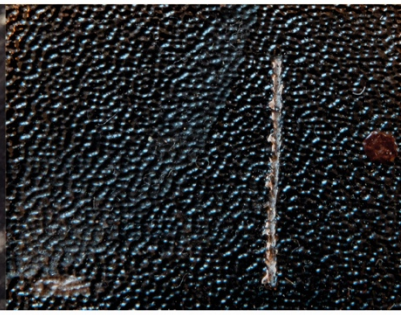


Figure F1.8

F1.9 Binnenbeits
F1.10 Result

Figure F1.9

Figure F1.10

F1.11 Decowax
F1.12 Result

Figure F1.11

Figure F1.12

F2. Coatings
BioPin coating

F2.1 BioPin coating
F2.2 BioPin coating applied to CB1 laminate

Figure F2.1

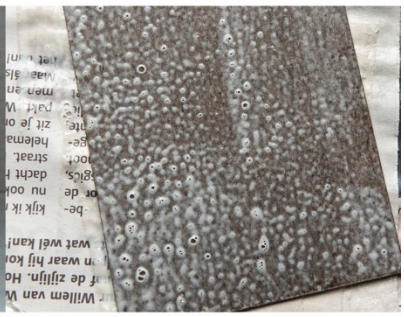


Figure F2.2

F2.3 Before dishwasher test
F2.4 After dishwasher test

Left: non-coated
Right: coated

Figure F2.3

Figure F2.4

F2.5 Scratch impact without coating
F2.6 Scratch impact with coating

Left: With brick
Right: Without brick

Figure F2.5

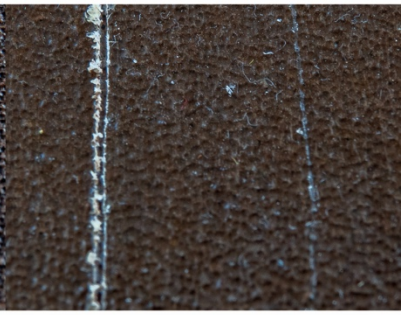


Figure F2.6

G. Cores
Cardboard honeycomb

G1.1 Before laundry mangler
G1.2 After laundry mangler

Figure G1.1

Figure G1.2

G1.3 Problem: too much pressure
G1.4 Problem: unequal distributed pressure

Figure G1.3

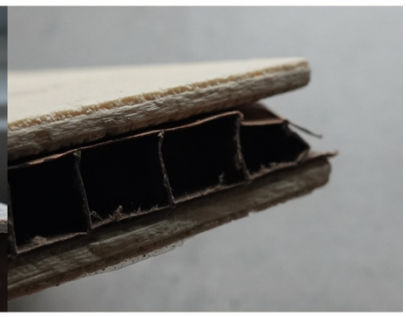


Figure G1.4

G1.5 V-cut
G1.6 90deg angle because of the V-cut

Figure G1.5

Figure G1.6

G1.7. DIY honeycomb step 1
G1.8. DIY honeycomb step 2

Figure G1.7

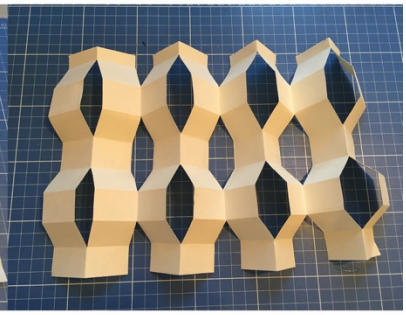


Figure G1.8

G2. ECOR layers

G2.1 The four layers needed to obtain enough mechanical properties for a furniture panel

G2.2 Adhering these together using pressure clamps.

Figure G2.1

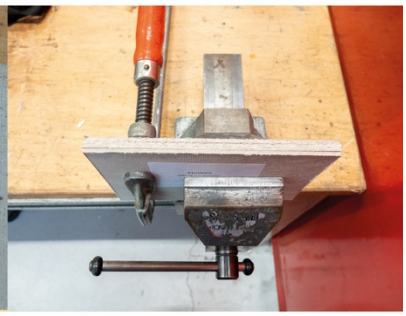


Figure G2.2

G2.3 ECOR laminated with CB1 laminate

G2.4 ECOR compared to Resysta NoWood and EcoBoard

Figure G2.3

Figure G2.4

G3. Plywood Bending

G3.1 The aim: picture from the internet.

G3.2 Failure to reproduce. Using a saw.

Figure G3.1

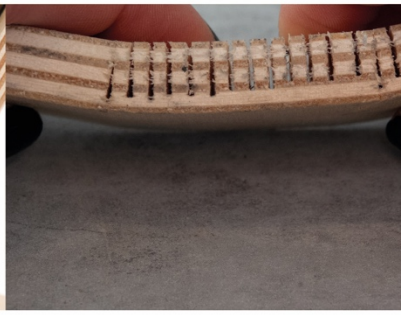


Figure G3.2

G3.3 and G3.4
Failure to dissassembly the plies by applying oil

Figure G3.3

Figure G3.4

G4. Resysta NoWood

G4.1 Top: 20mm thick
G4.1 Bottom: 9mm thick

G4.2 Top: Sanded
G4.2 Bottom: Not sanded

Figure G4.1

Figure G4.2

Molding by heat

G4.3 By oven: pressed into perpendicular shape
G4.4 By oven: wrapped around a shape

Figure G4.3

Figure G4.4

Laser cut engravement

G4.5 Flame ingnition
G4.6 Result

Sides: charred, like MDF
Orange dust: unknown

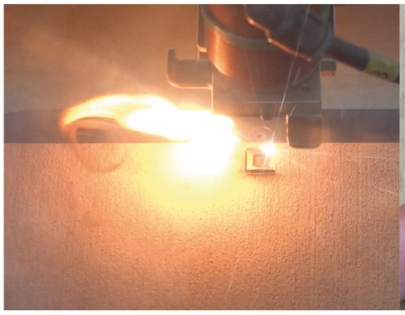


Figure G4.5

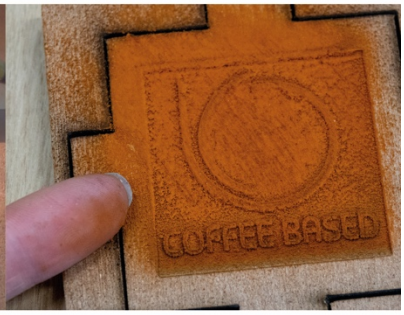


Figure G4.6

Dishwasher impact

G4.7 Settings that caused the Resysta to melt
G4.8 Settings that did not

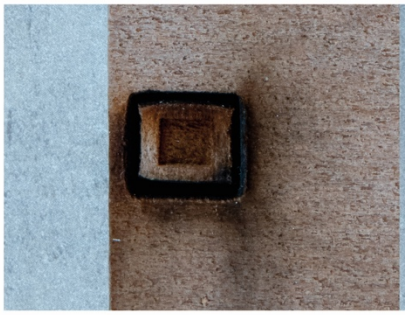


Figure G4.7

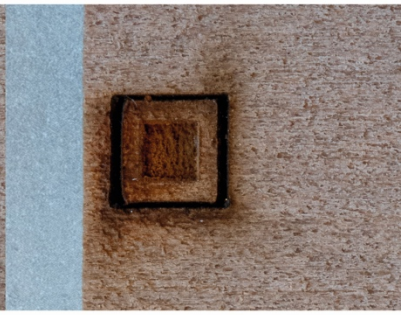


Figure G4.8

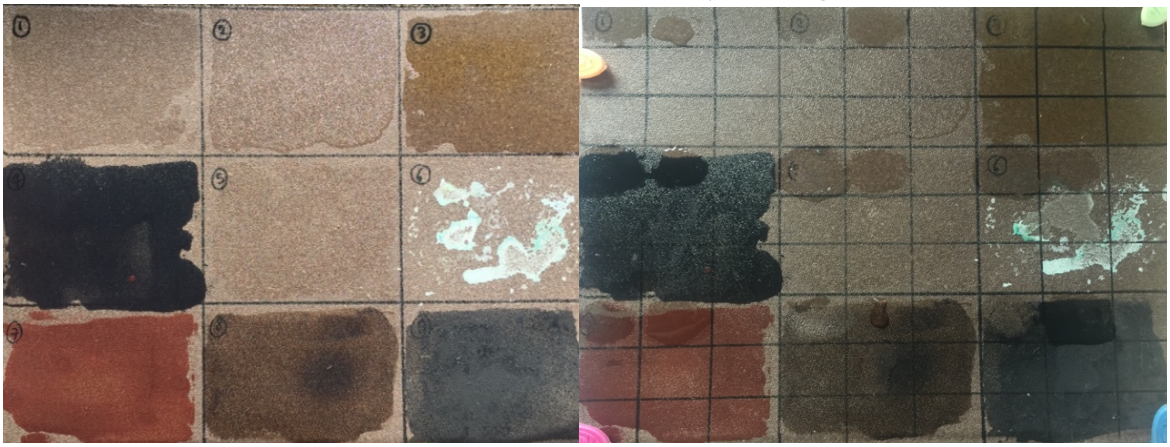
Dishwasher impact

G4.9 With BioPin coating
G4.10 Without BioPin coating

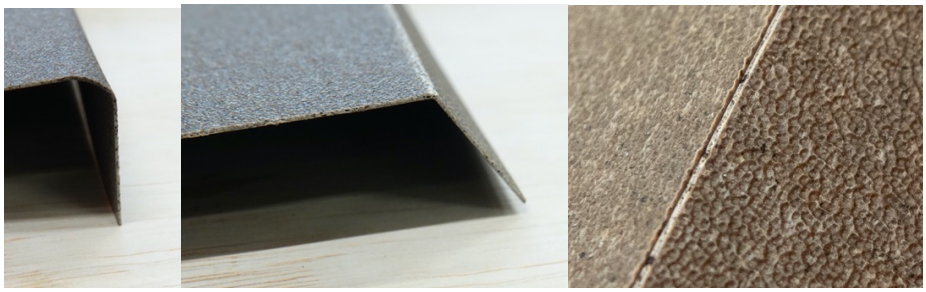
Figure G4.9

Figure G4.10

Undesired Fossil-based / formaldehyde coatings



Different types of lacquers and varnished tested on the CB1. Add names with numbers (1) Floor lacquer, (2) Acrylic transparent lacquer, (3) yacht coating, (4) wood stain, (5) cleansing gel, (6) antique solution, (7) wood stain mahogany, (8) deco wax and (9) schoolboard paint.

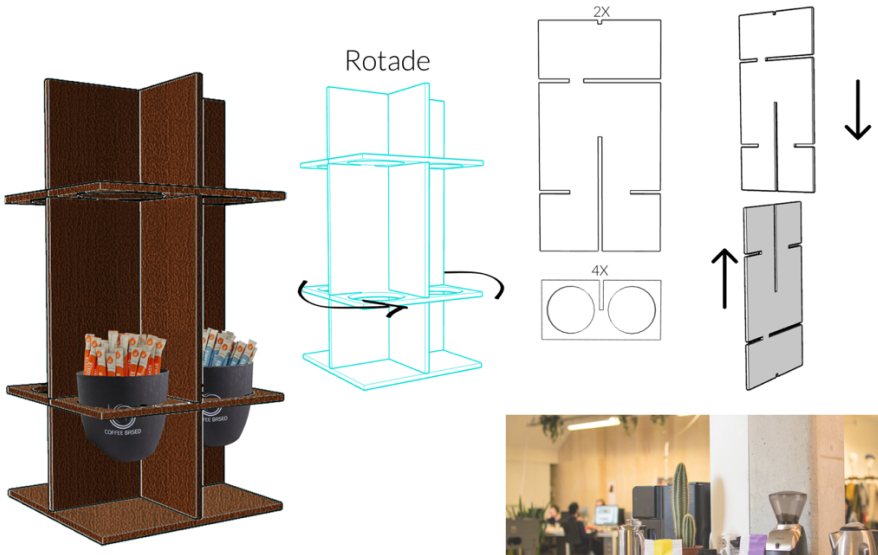


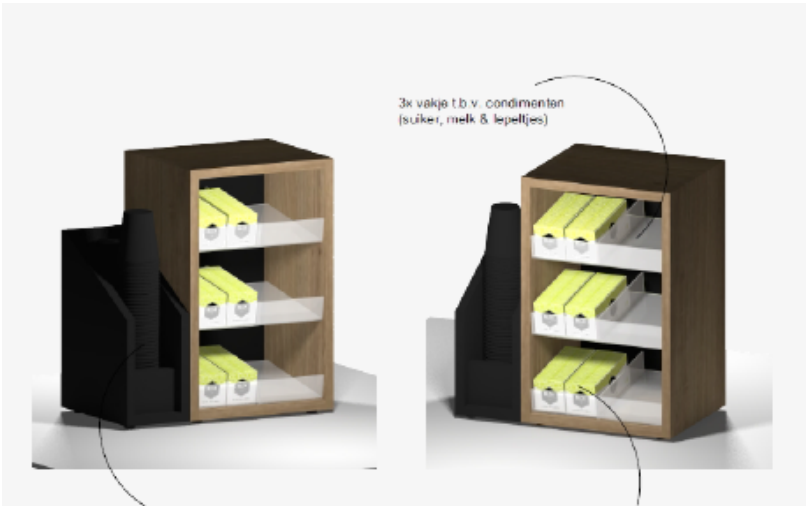
Alternatives to cover the edges by hot wire (left), metal sheet press (2) and cut by knife (3)

Appendix F. Ideation sketches

Start of the project

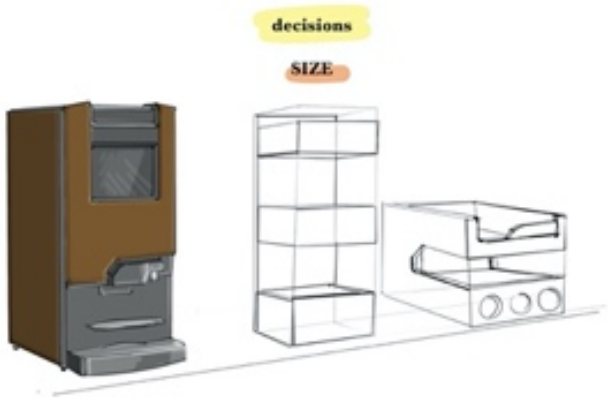
Design ideas by a previous intern.

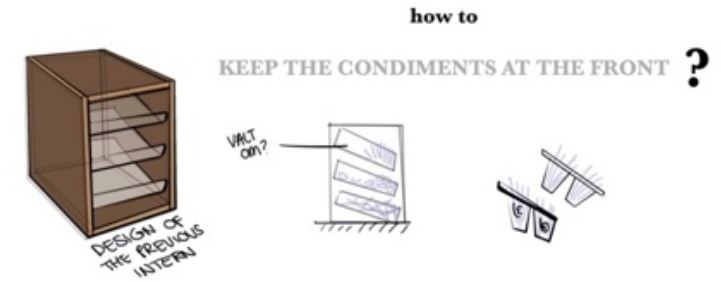


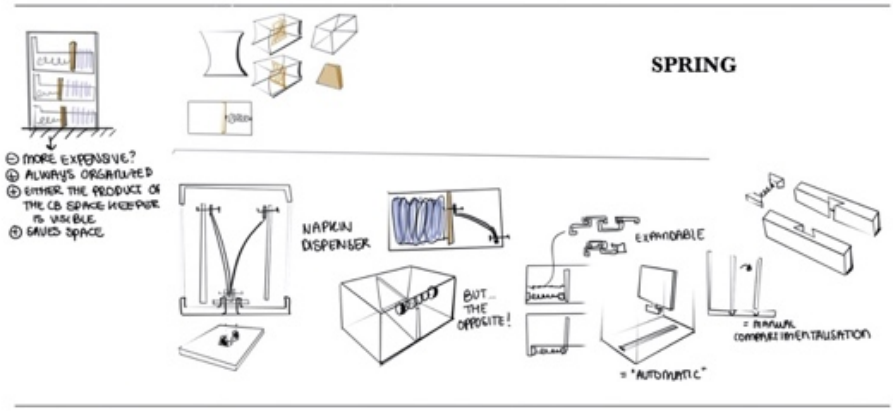


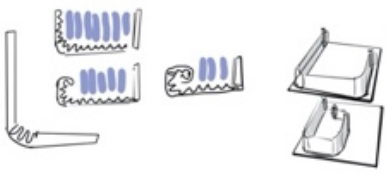
And my own translation of those ideas:

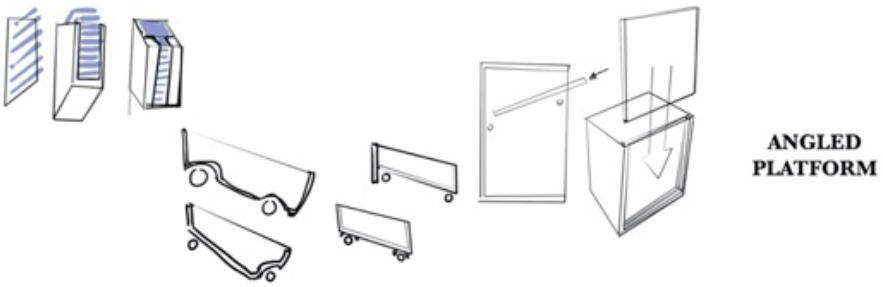
Design questions





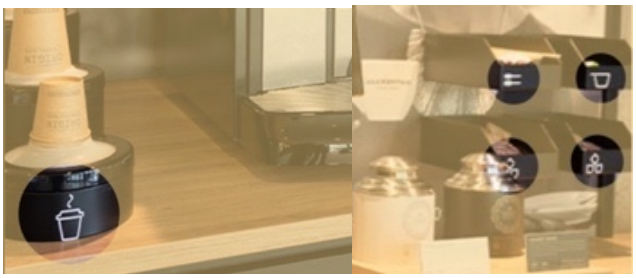


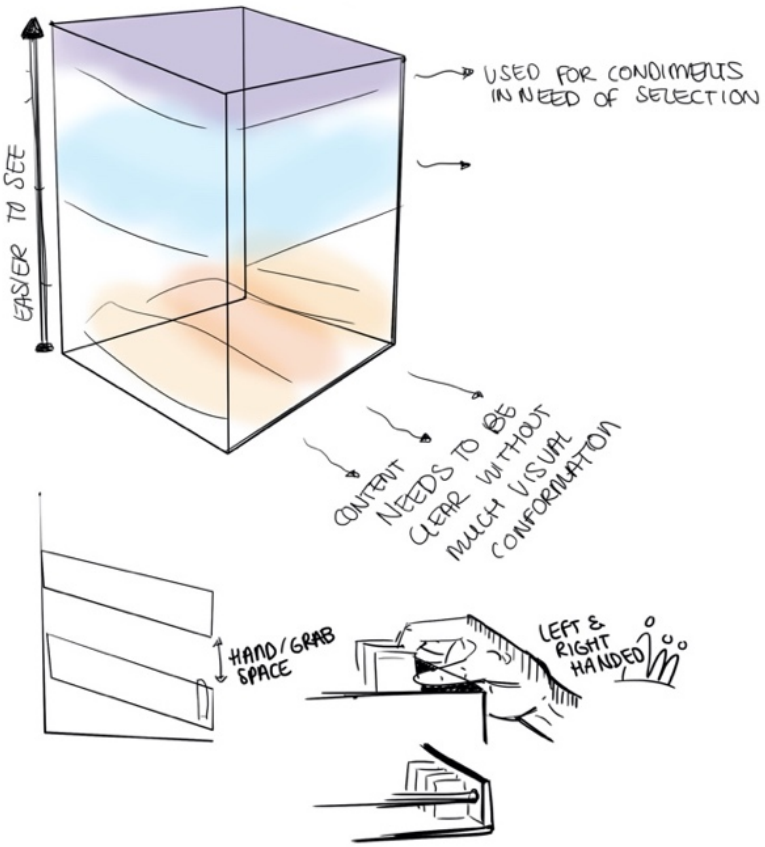


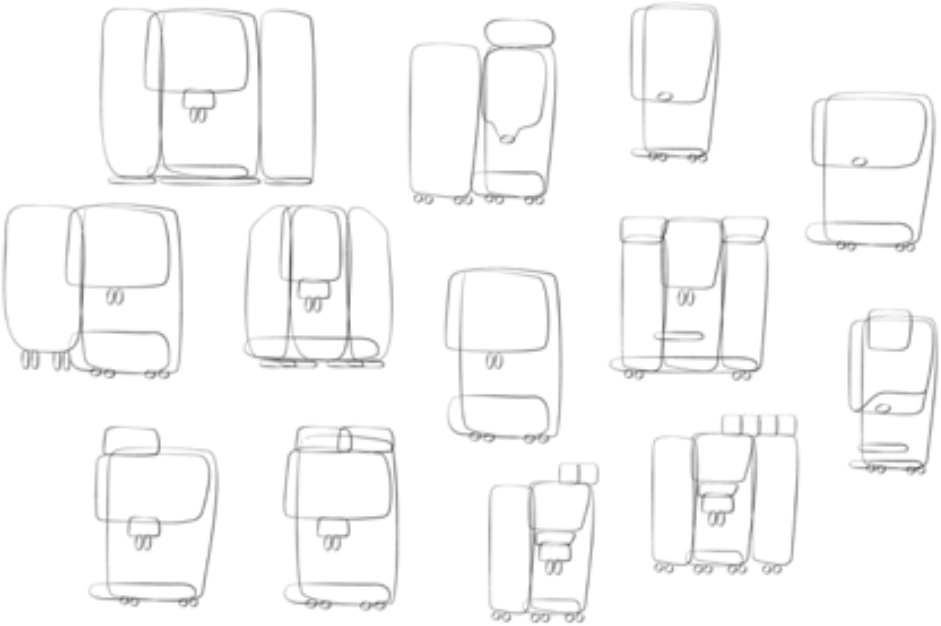


how to

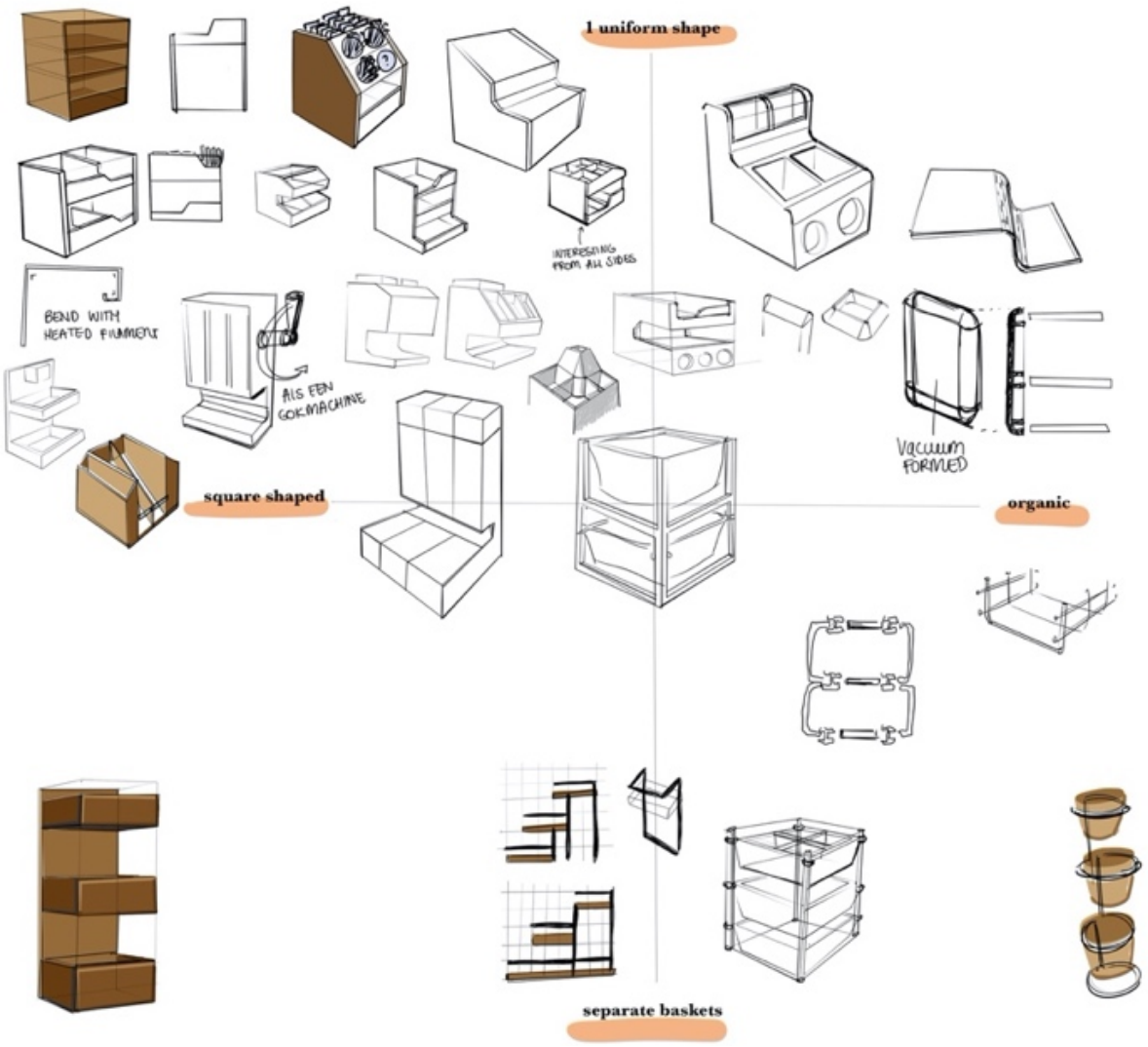
SHOW SUSTAINABLE CHARACTER




EASIER TO SEE
USED FOR CONDIMENTS IN NEED OF SELECTION
CONTENT
NEEDS TO BE CLEAR WITHOUT MUCH VISUAL CONFORMATION
HAND/GRAB SPACE
LEFT & RIGHT HANDED

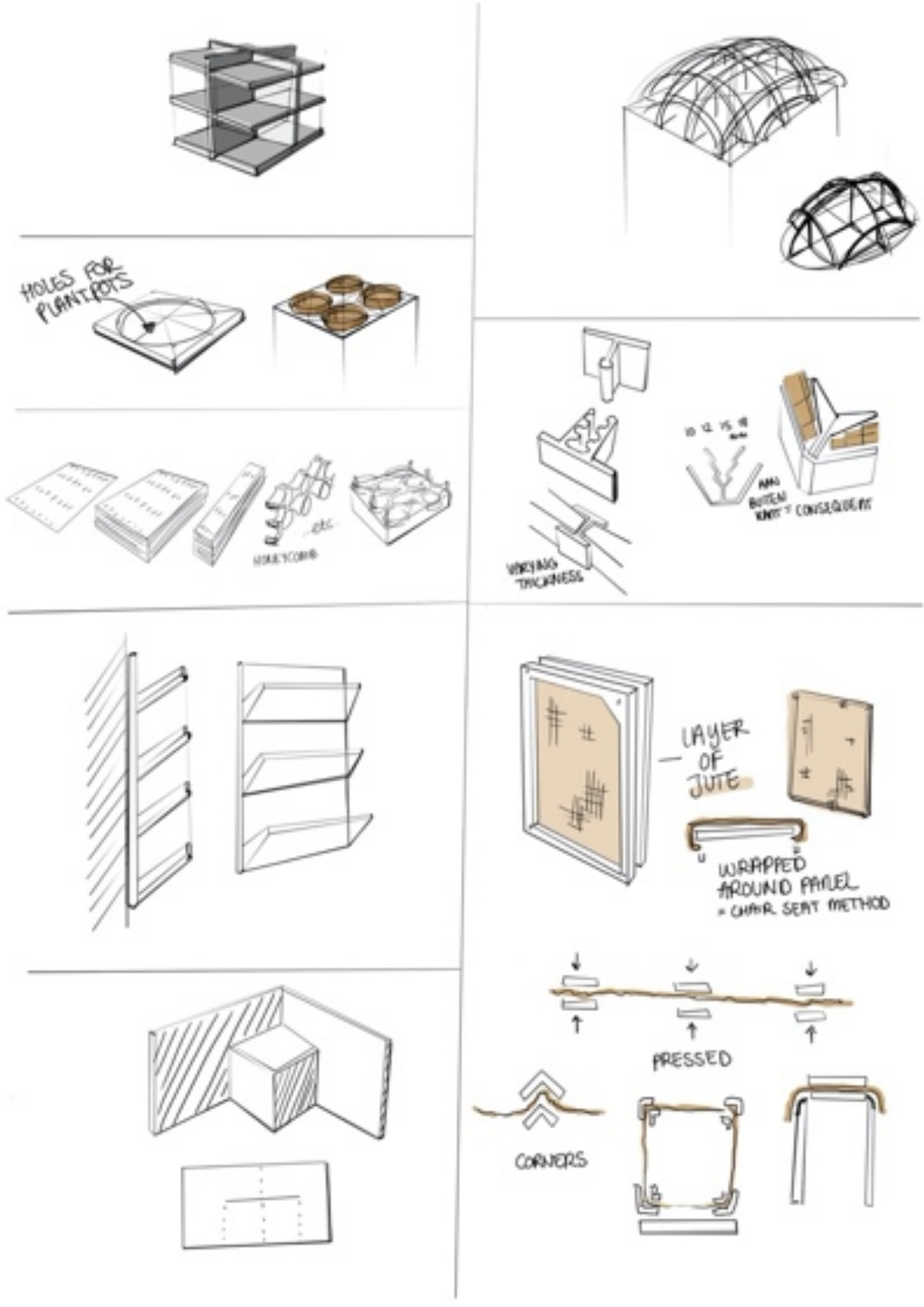


Clusters

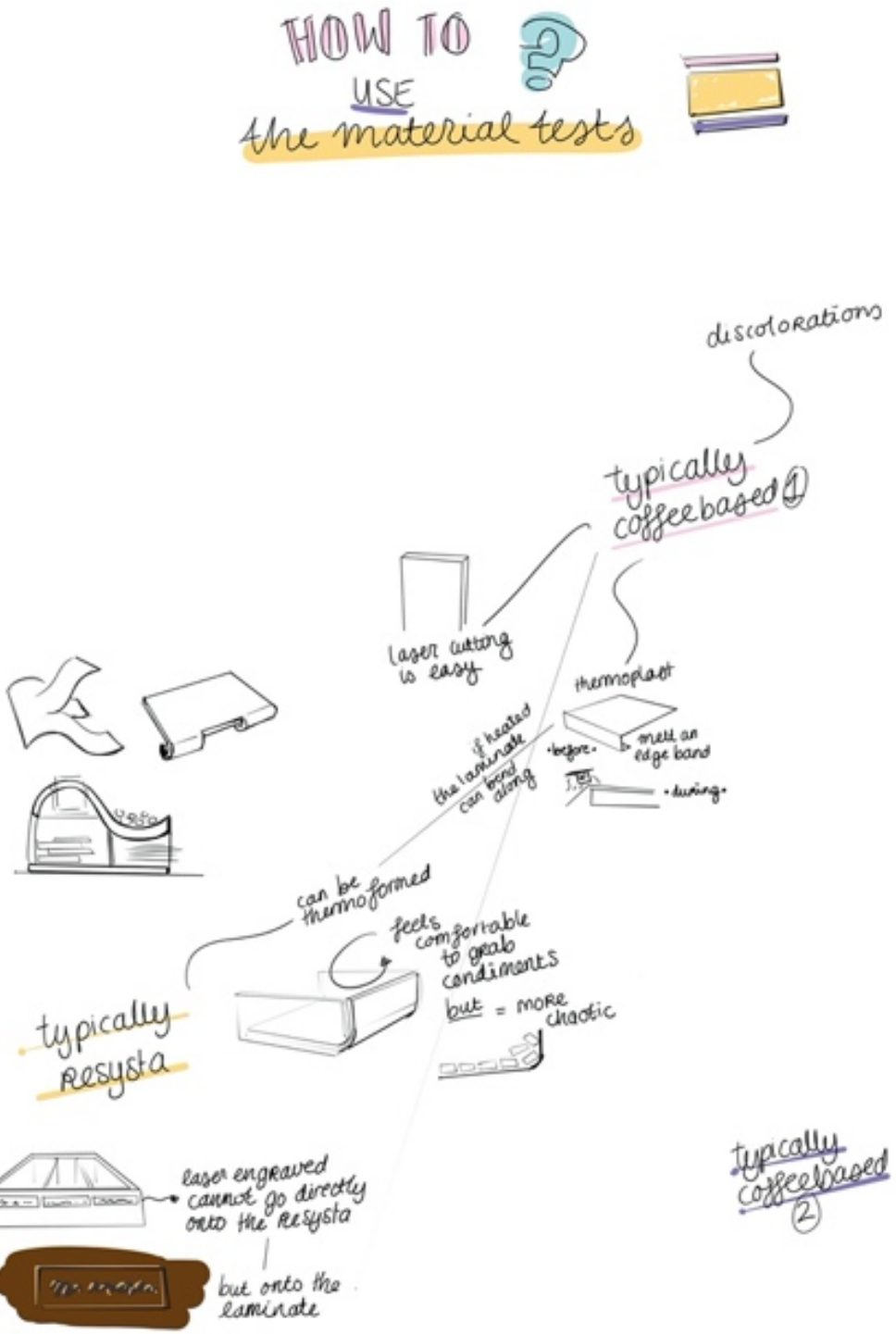

1 uniform shape
BEND WITH HEATED FILAMENT
ALS EEN GOEDMACHINE
INTERESTING FROM ALL SIDES
Vacuum FORMED
square shaped
organic
separate baskets

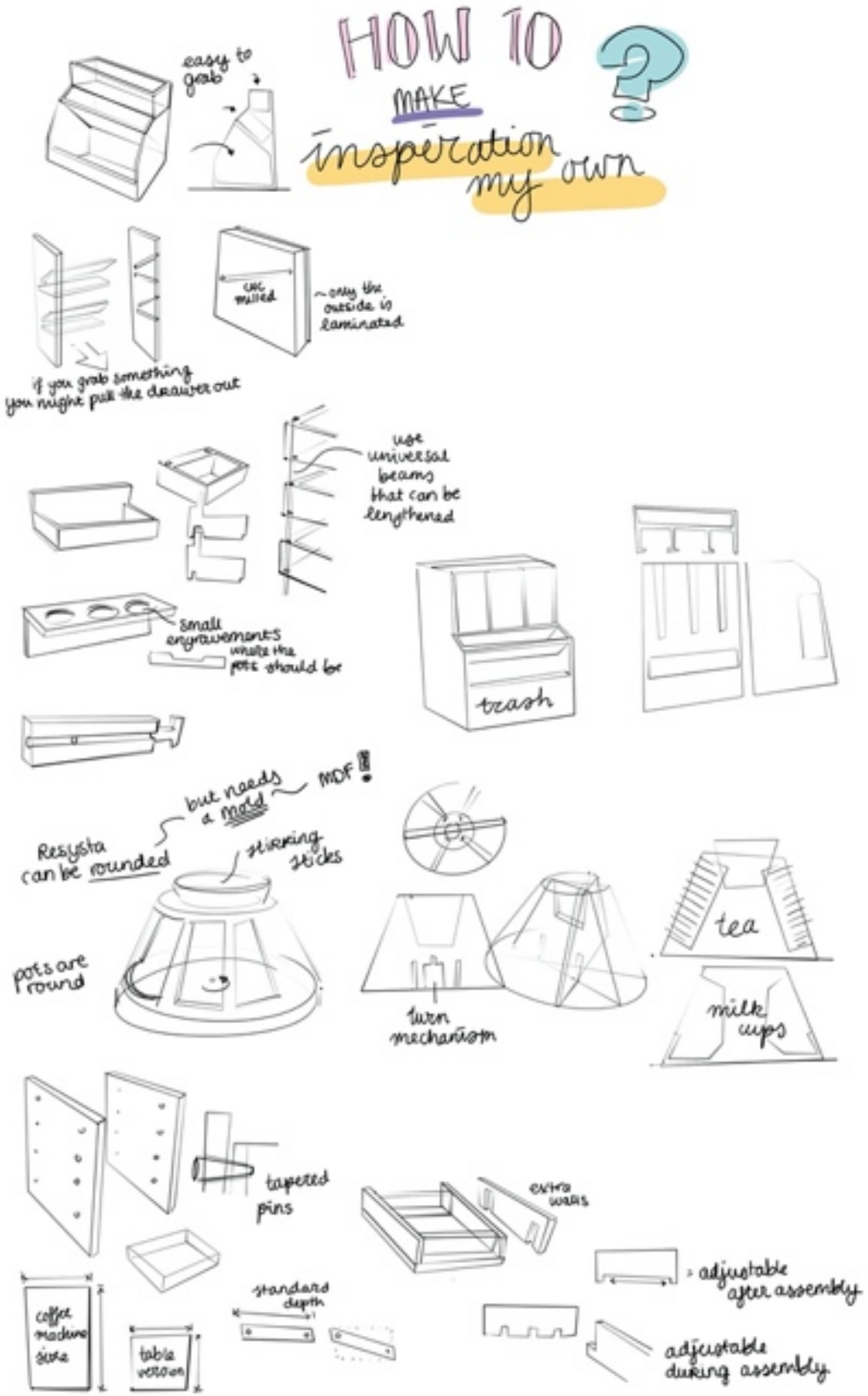
Competitor products similar to the clusters

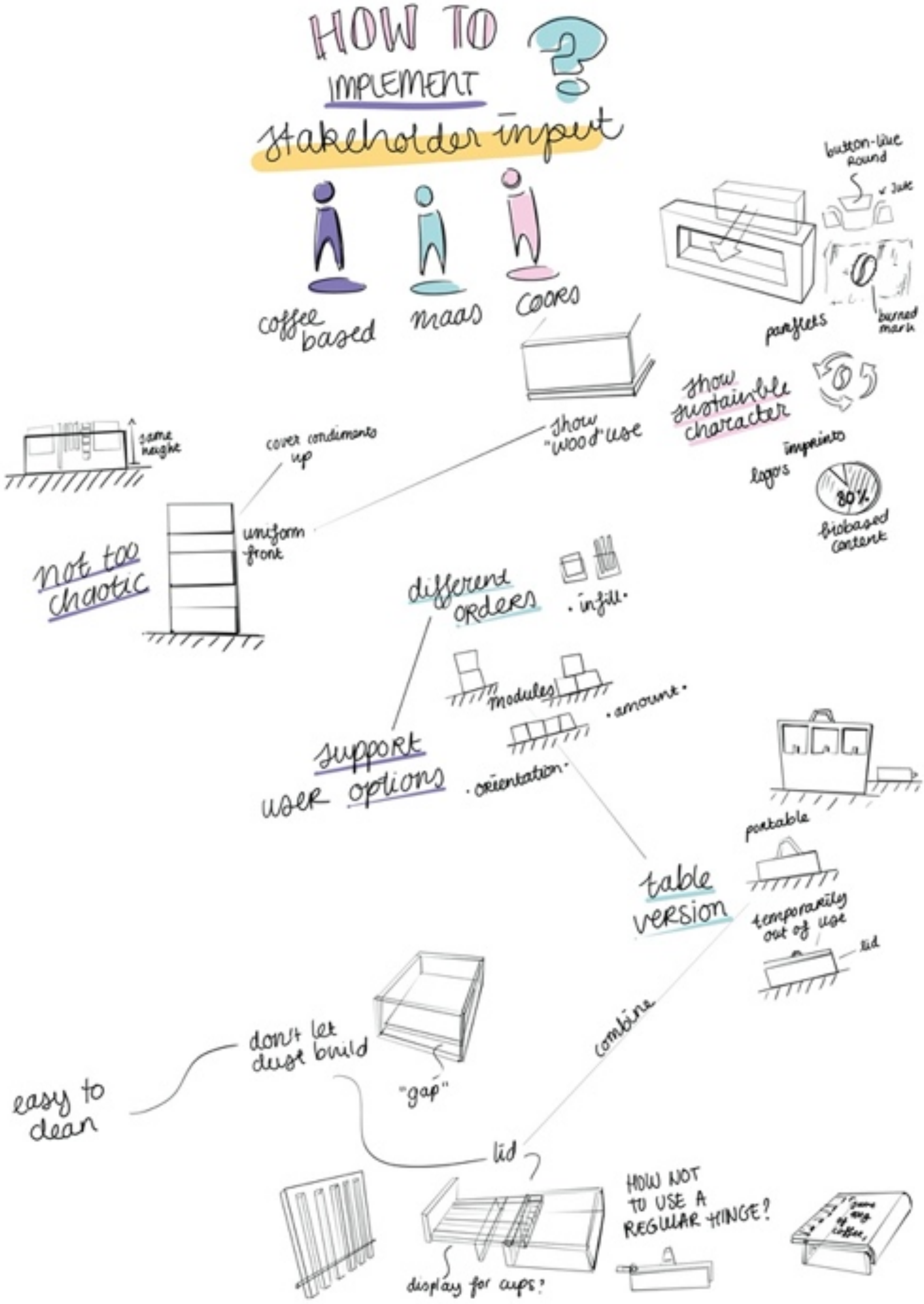
Separate ideas



How-to questions




HOW TO
MAKE
inspiration
my own
easy to grab
cnc milled
only the outside is laminated
if you grab something you might pull the drawer out
use universal beams that can be lengthened
small engravements where the pots should be
trash
but needs a mold
MDF
Resista can be rounded
stirring sticks
pots are round
turn mechanism
tea
milk cups
tapered pins
extra walls
adjustable after assembly
coffee machine size
standard depth
table version
adjustable during assembly


HOW TO
IMPLEMENT
stakeholder input
coffee based
maas
coors
button-like
Round
burned mark
pamflets
show sustainable character
imprints
logos
80%
biobased content
show "wood" use
cover condiments up
same height
uniform front
not too chaotic
different ORders
infill
modules
amount
support user options
orientation
portable
table version
temporarily out of use
lid
combine
don't let dust build
"gap"
easy to clean
lid
HOW NOT TO USE A REGULAR HINGE?
display for cups?


HOW TO DESIGN sustainable?
1 use sustainable materials
2 use what is already available
3 Reduce transport
weedpot style allowed to be an option
jute
transparant PLA
Reuse the molds
• cups • plantpots • extruder nozzle sheet
add to shapes
border to prevent fall out
• horizontal • vertical
universal connector piece
flat packaging
diy assembly
shape of a beam
laminate
slats practically invisible if not in use
add front side
OR under an angle
HALF
QUARTER
take products apart
• cut • saw • laser cut
Reshape products
OR
create small edge
inside eachother
combine products
(partially) hide products
use details as benefit
watch out for bucket look = cheap
beer-holder
add bottom

Appendix G. Brainstorm session

What did two independent participants think?
The brainstorm session was held with 2 students from the Master of Integrated Product Design at the TU Delft. Both participants (1male and 1 female) were asked the numbered questions at the same time as documented below, only in Dutch. Relevant statements are translated into English, unless stated otherwise. This, because the competence of using the English language is a requirement for the master's degree this report belongs to.

(1) What do you envision if I say: "Condimenten rekje" (English: condiment organizer)?
Male participant (M):
- "I think of spices. You can put the small glass round containers inside these holes. And the word 'condiments' sounds like continents, which can refer to the continents the spices originate from!" [..] "I think the rack should be mounted to the wall."

Female participant (F):
- "Never heard of the word condiments, I suppose it refers to spoons and spices? Small stuff. It should be open, and I want to be able to hang stuff from it."

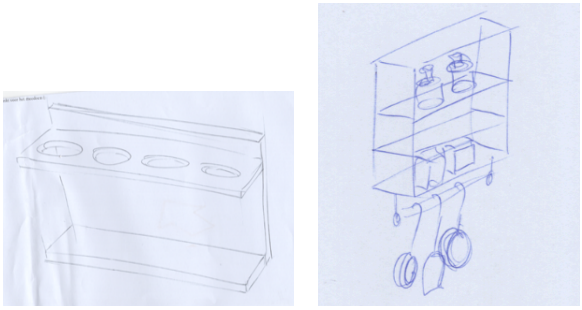


Figure XXX.

(2) The name condiment racks, or condiment organizers, refers to the product often displayed next to a coffee machine. It holds condiments, or supplements, that add flavor to the coffee or tea that is consumed. Let's take this stirring stick, tea bag, milk cup and sugar sachet as condiment examples. How would you a) orient these inside an organizer, b) prefer to pick them up and c) would you like them to be organized?

(F): "My parents put everything away except for their favorite tea flavor. I however, prefer to make having a tea more of a moment. The tea pot and plate of cookies are nicely displayed. The tea box needs to be pretty too." [..] "I also like to have my coffee displayed in a pretty container as well".

(M): "I imagine these ugly things that an employee puts on the table, kind of bored. These things stand on the table, instead of being mounted to the wall. At the DE coffee corner the ingredients are presented better, you WANT to have one of these coffees. "

The stirring stick, tea bag, milk cup and sugar sachet displayed during the brainstorm.

Stirring sticks
Organized? Yes! Because the stick will come into direct contact with your drink, it will need to hygienic in its orientation.
Orientation:
- Standing up, but 1 needs to stand out.
- You push 1 stick up with a button, so you can grab it from the top with your other hand.
- It's a slide, there is always 1 at the bottom of the slide.
- The stick at the front falls forward. If removed, it will be replaced by the next stick.
- They are stacked separately inside a frame. Grabbing one, will not make the user come in contact with the others
- The stick is presented like the PEZ-candies. You open the container and 1 is presented.
Place to pick it up:
- From 1 side only. The other side of the stick will touch the drink. The user can keep the stick in its hand from the moment it is grabbed to the stirring movement.
- They should be grabbed with pliers, just like sugar cubes in public places.

Tea bags
Organized? Definitely, by its flavor. The flavor should be clearly displayed.
Orientation:
- Like a box of drill bits. You open a lid, and the bits are presented like a color wheel.

- They are stored horizontally and lifted with a 45 angle when displayed.
- Like a box of pantyliners.
Place to pick it up: at the side

Milk cups
(F): Organized? Yes. The bottom appears cheap.
Orientation: Preferably standing neatly and ordered with the lid towards me.
Place to pick it up: by the lid

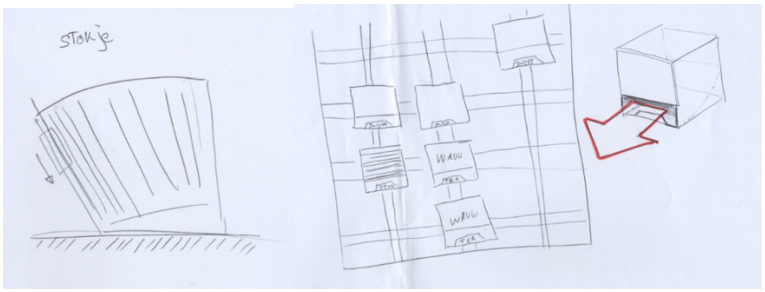
(M): Organized? Nah, not necessary.

Sugar sachets
Organized? No. If I grab one too many by accident, I usually keep them.
Orientation: Does not matter, the packaging is clearly meant for sugar. The context also dictates that it's not salt.
Place to pick it up: Does not matter, no part of the packaging will touch the food anyways.

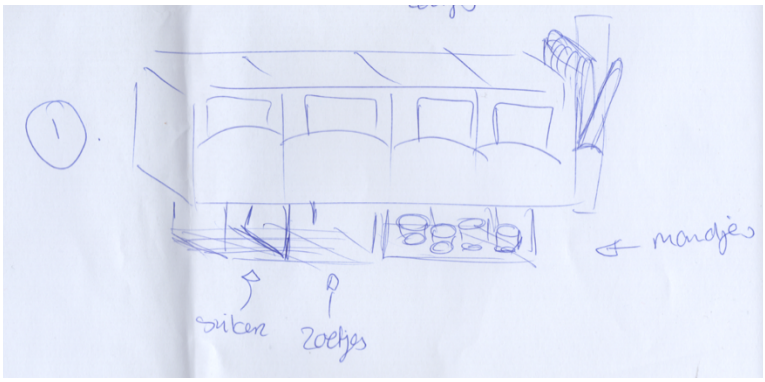
Other comments
Trash: Issue when you've got your hands full. I really do not want to touch the lid and don't want to walk away from my tea.

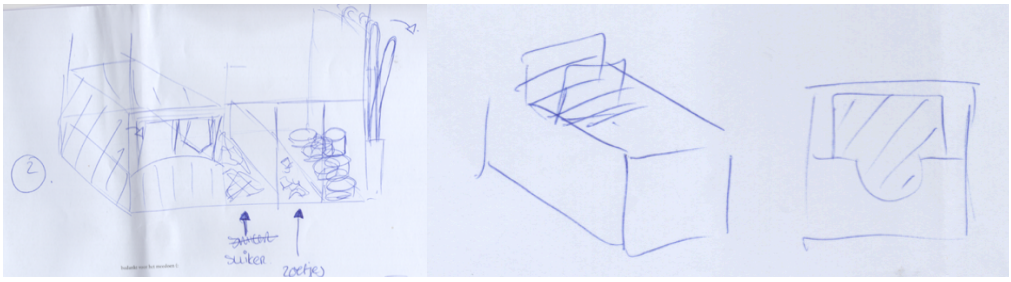
(3) Now that you are aware of what condiments are meant for the purpose of this project, is your vision on 'condiment organizers' changed? Please draw the redesign if it has.

Male participant: "You will only need 1 mold and universal connecting pieces."



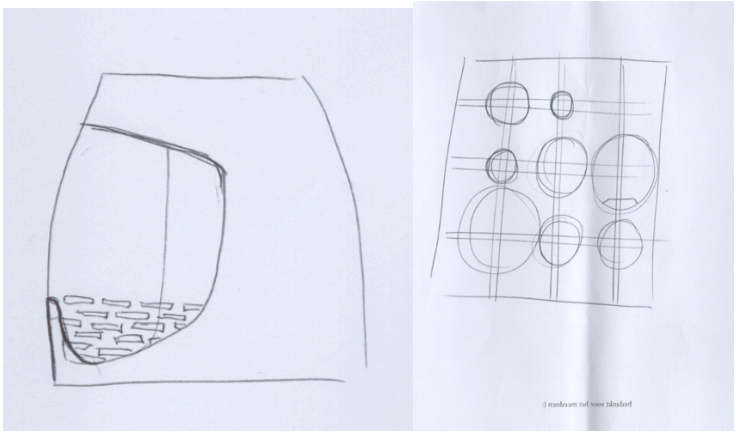
Female participant: "For the teabags, I want the compartments to be square shaped"



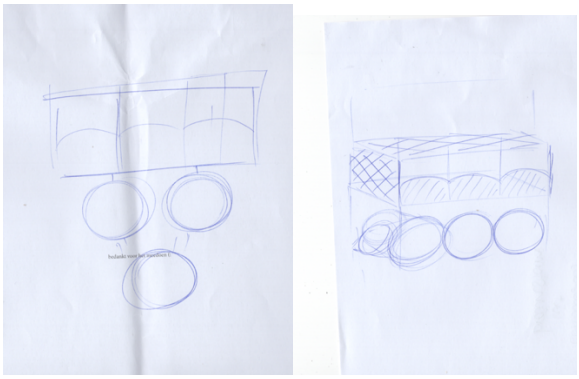


(4) The company is already familiar with manufacturing these 3 injection molded products: the cup size M, the cup size L and the plant pots. **If you had to implement these in your design, how would you do so? Please draw the redesign if it has changed.**

Male participant: "I can envision the plant pots being tilted and one of them has this cute plant hanging from it."



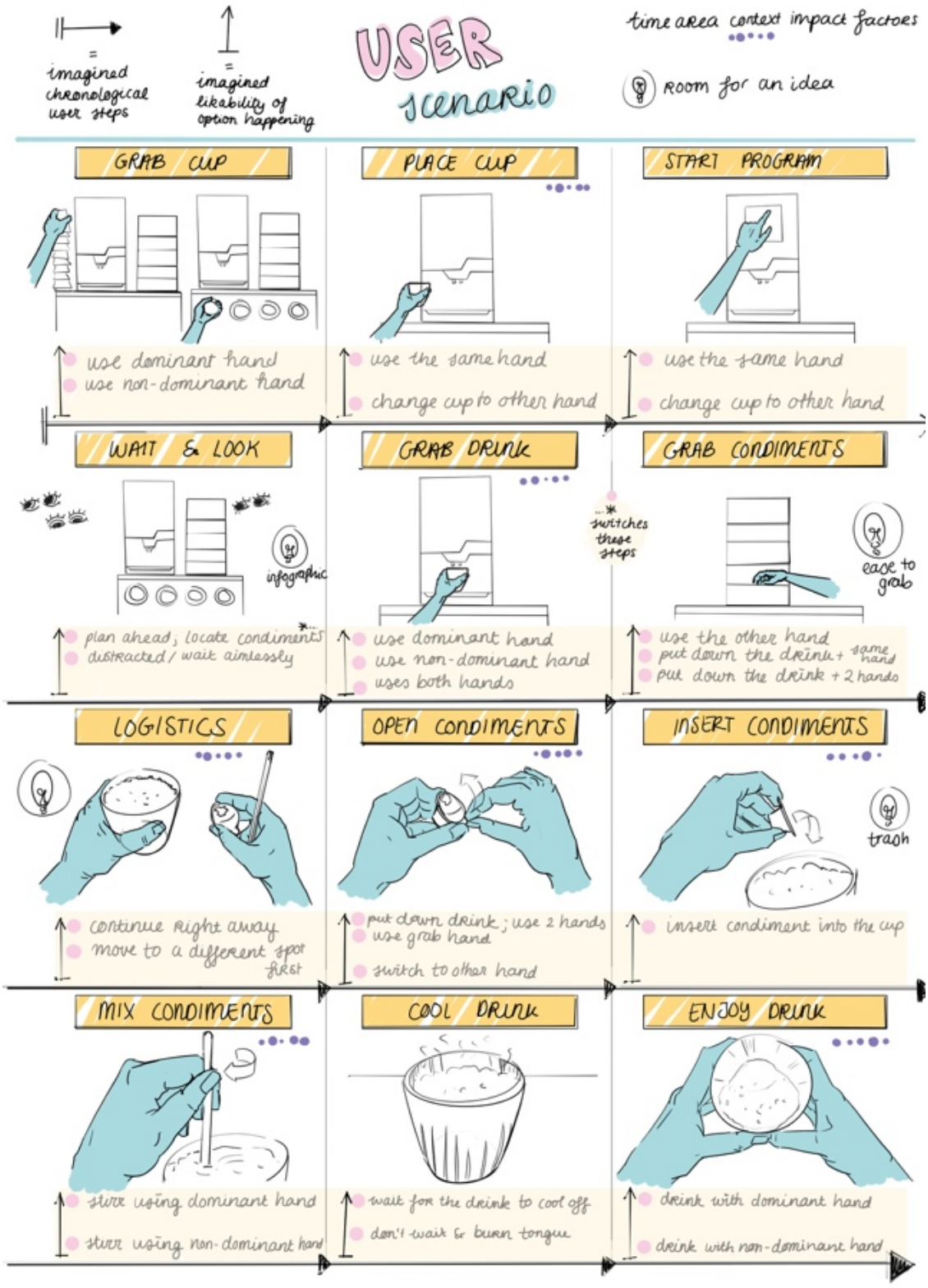
Female participant: - "The exterior shape of the drinking cups reminds me of a car wheel".
- "Wow, they fit inside each other if you turn one of them around!!"
- "Using the cup would feel cheap. I want my organizer to be made of wood and steel. It should look luxurious."



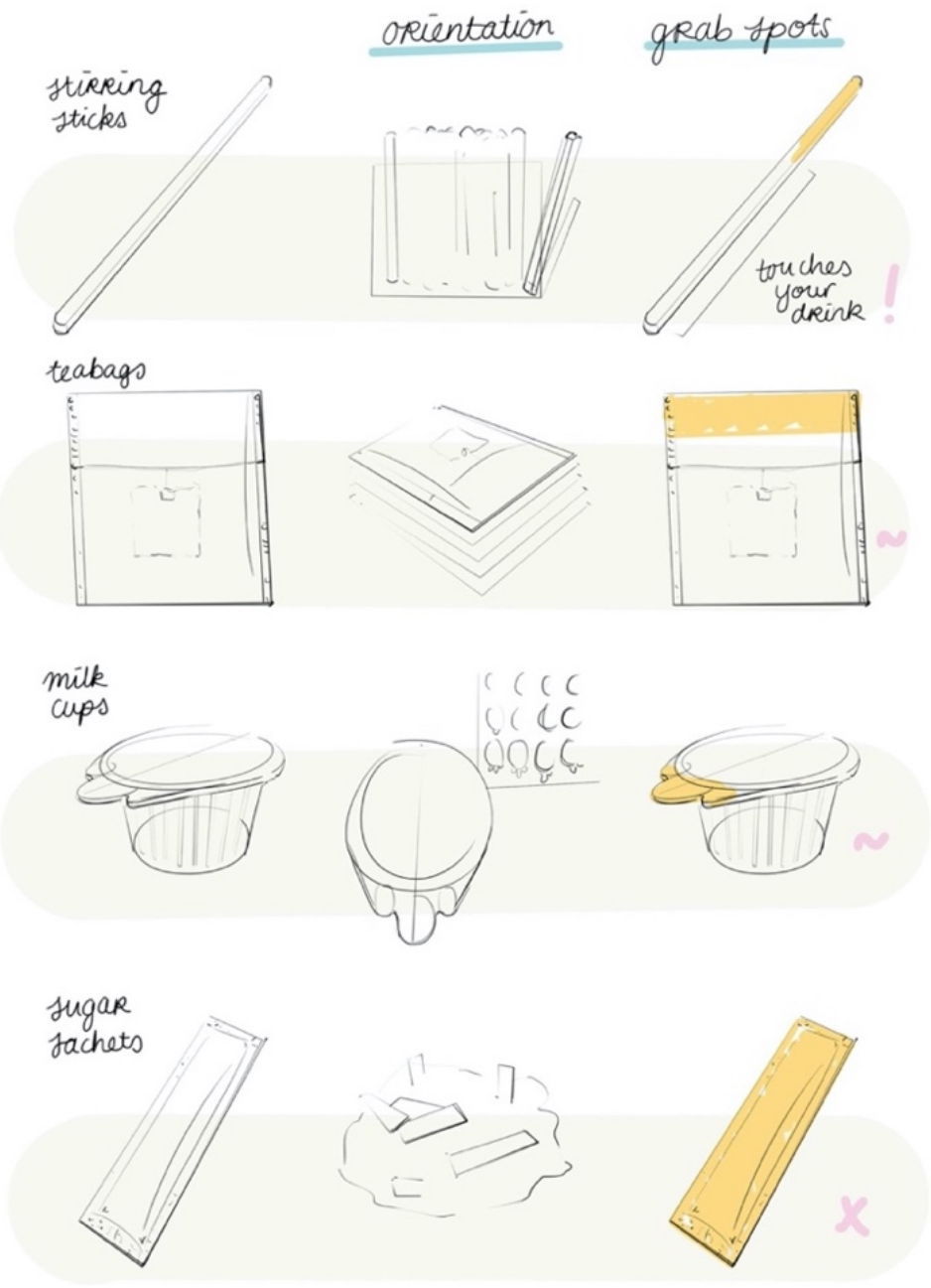
Brainstorm session with two other graduating students from the faculty from Integrated Product Design.

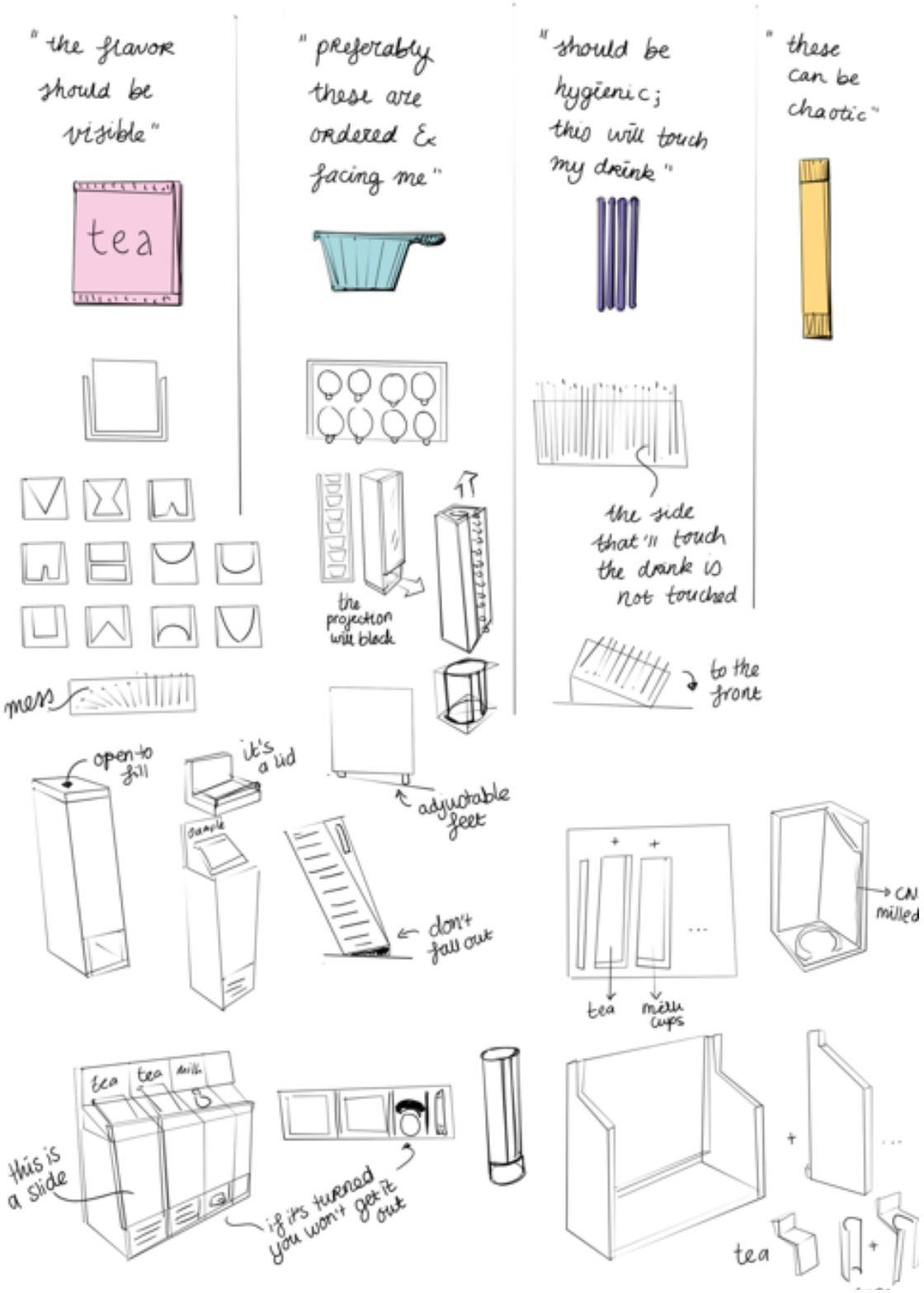
Appendix H. Brainstorm output

User scenario

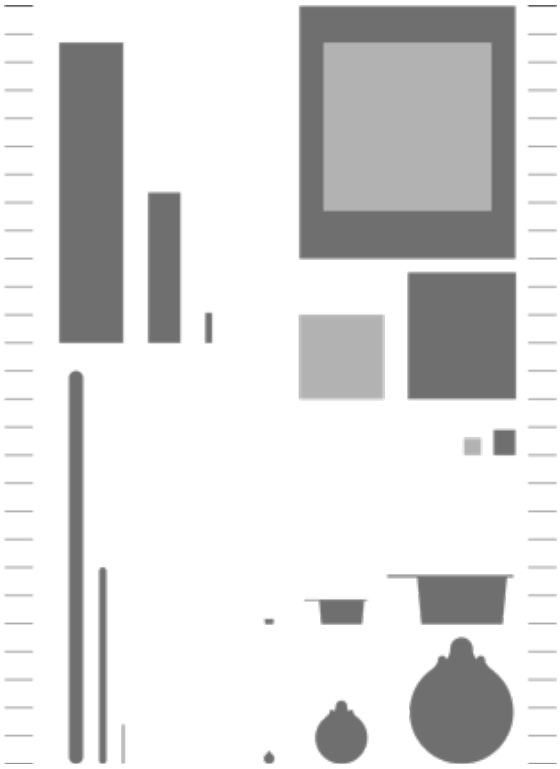


Orientation of condiments



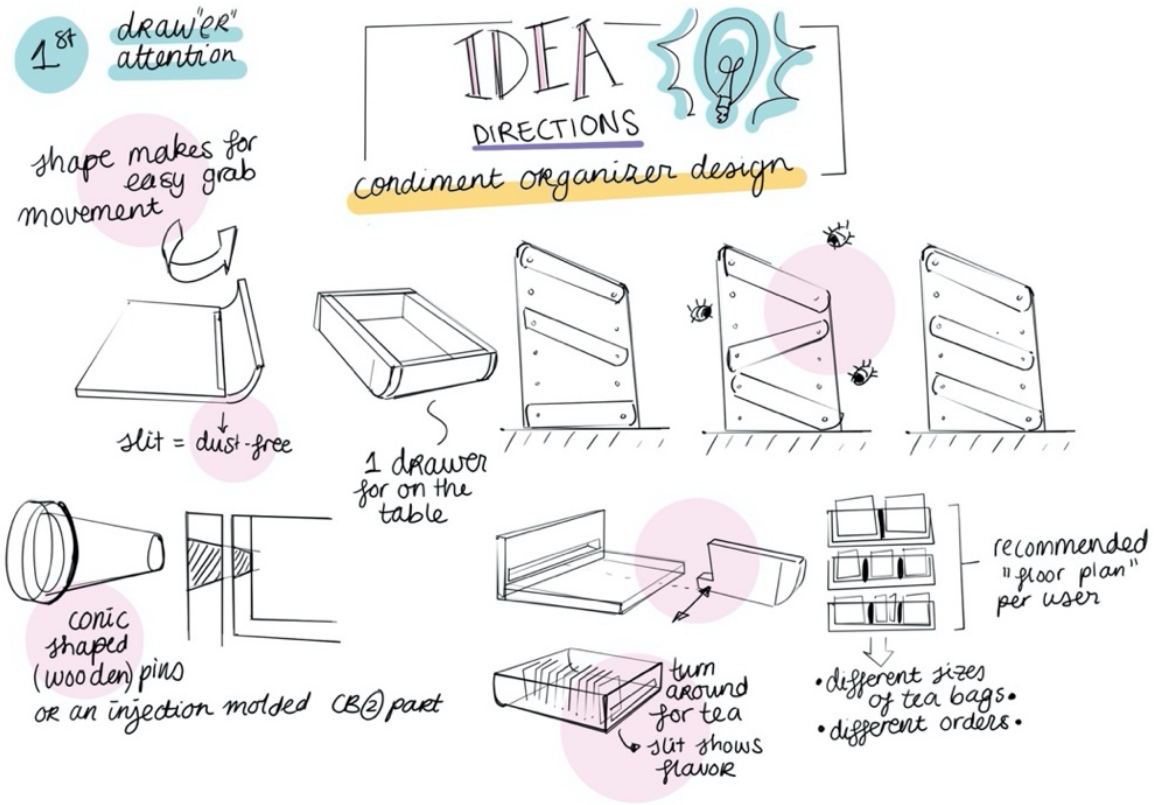

" the flavor should be visible"
tea
" preferably these are ordered & facing me"
" should be hygienic; this will touch my drink "
" these can be chaotic"
the side that'll touch the drink is not touched
to the front
the projection will block
open to fill
it's a lid
adjustable feet
don't fall out
CN milled
tea
this is a slide
if it's turned you won't get it out

Physical attributes were also made to help the creative flow, including but not limited to a life-size cardboard coffee machine mock-up and a print of the chosen condiments in different scales.



Appendix I. Four idea directions

1st idea. It's a basket case

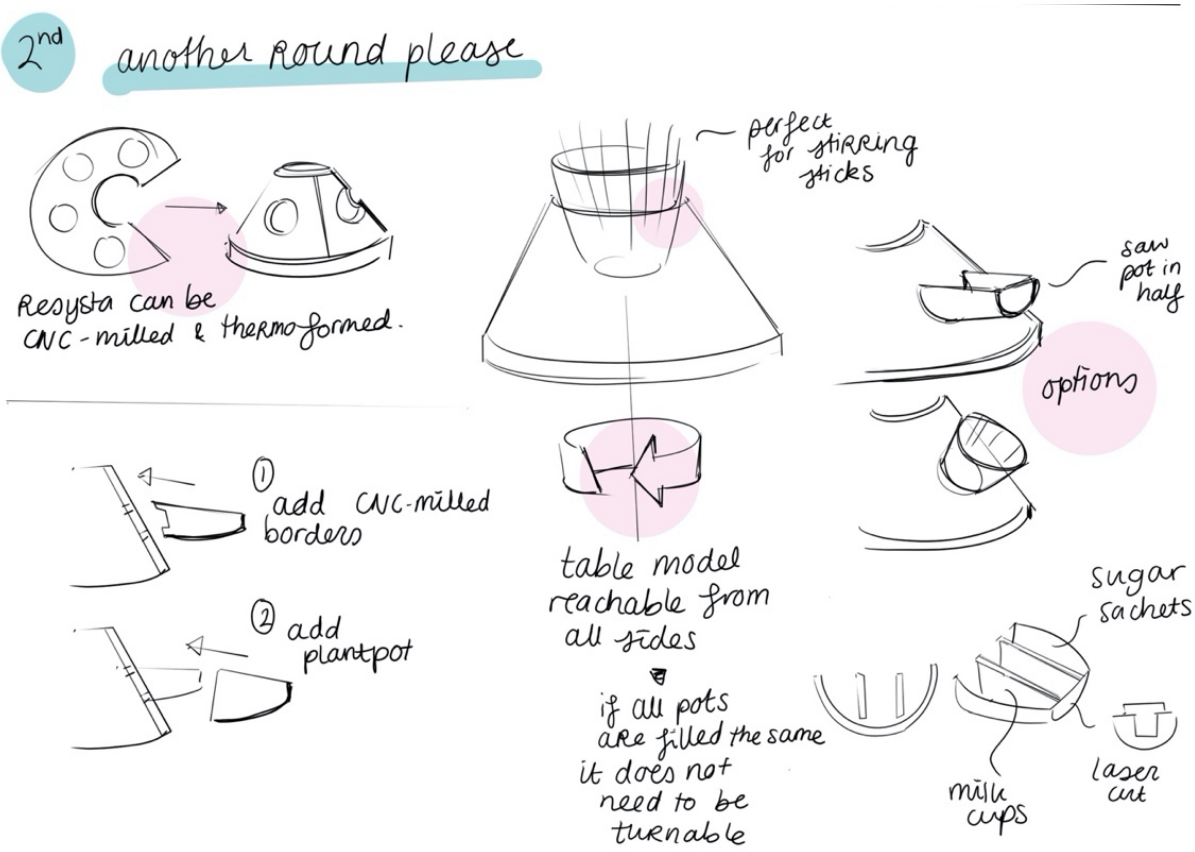


Description: The product consists of 2 side walls with multiple holes each. Small baskets can be pinned on desired height under a favored angle using the 4 pins provided with each ordered basket. This design utilizes the fact that the core material, Resysta NoWood, can be thermoformed into any shape. The panel would only need to bend in a singular direction to create the base for the basket, avoiding a need for expensive molds. A simple MDF mold would suffice, especially for a small batch product. The rest of the walls can easily be cut from a panel using CNC milling. The pins can be off-the-shelf or made with an injection mold machine. Small basket dividers can be placed within the baskets and moved along its width, up to preference. As corporates are known for ordering different condiments from different brands based on their preference and coffee machine type, this flexibility is desired.

Pros:
(+) The baskets have a slit, preventing dust from forming.
Cons:
(-) Thermoforming the base is manual labor.

CB feedback: "The idea of using baskets and side walls would suit the request from MAAS perfectly. However, the utilizing the thermoformability of the Resysta NoWood does increase production investments and manual labor. It should be checked whether or not our manufacturer has the facilities to produce such products".

2nd idea. Another round please!

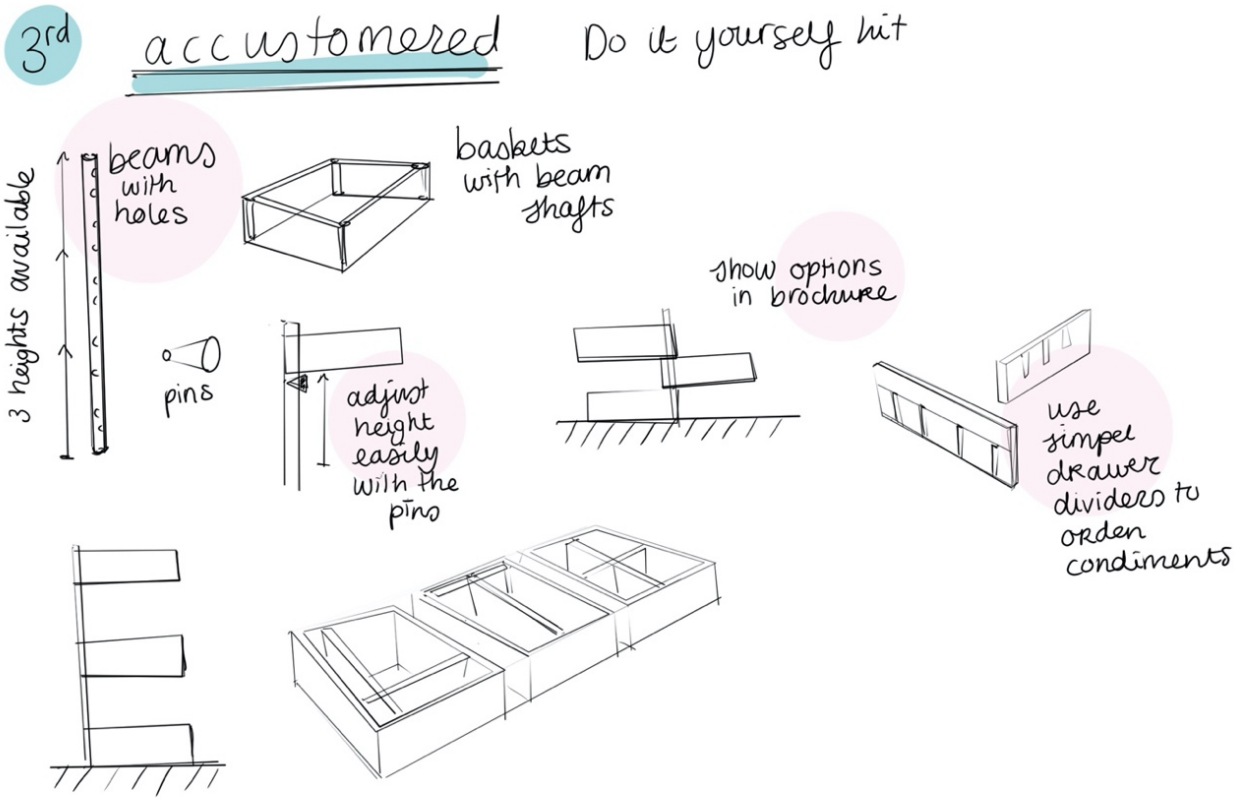


Description: MAAS mentioned that a condiment organizer with the purpose to provide condiments during conferences/meetings was also an interesting direction. This second idea focusses on this statement. Furthermore, the design is based on the utilization of the existing injection molded products, namely the plant pots and Lucky Cups. The resembled circular shapes of the cups in combination with the thermoformability of the core material was inspiration for this conic design. Depending on the production costs, the conic shape could be implemented with a product architecture allowing for circular movements. Turning the baskets allows easy access to all condiments no matter the location, suitable for meetings with employees surrounding a table on all sides. Containing condiments inside these pots would automatically mean chaos. Therefore, the design implements laser cut / CNC cut walls that can create order and structure in the chaos.

Pros:
(+) The baskets are already in production.
(+) Adds a different type of condiment organizer to the product portfolio of MAAS.
Cons:
(-) The Resysta NoWood needs a mold to be thermoformed around

CB feedback: "The form language does not seem to fit the CoffeeBased furniture panels, nor the coffee machine front cover. Also, the condiment organizer does not need to be designed for the conference room purpose, if it's up to us."

3rd idea. Customized to taste

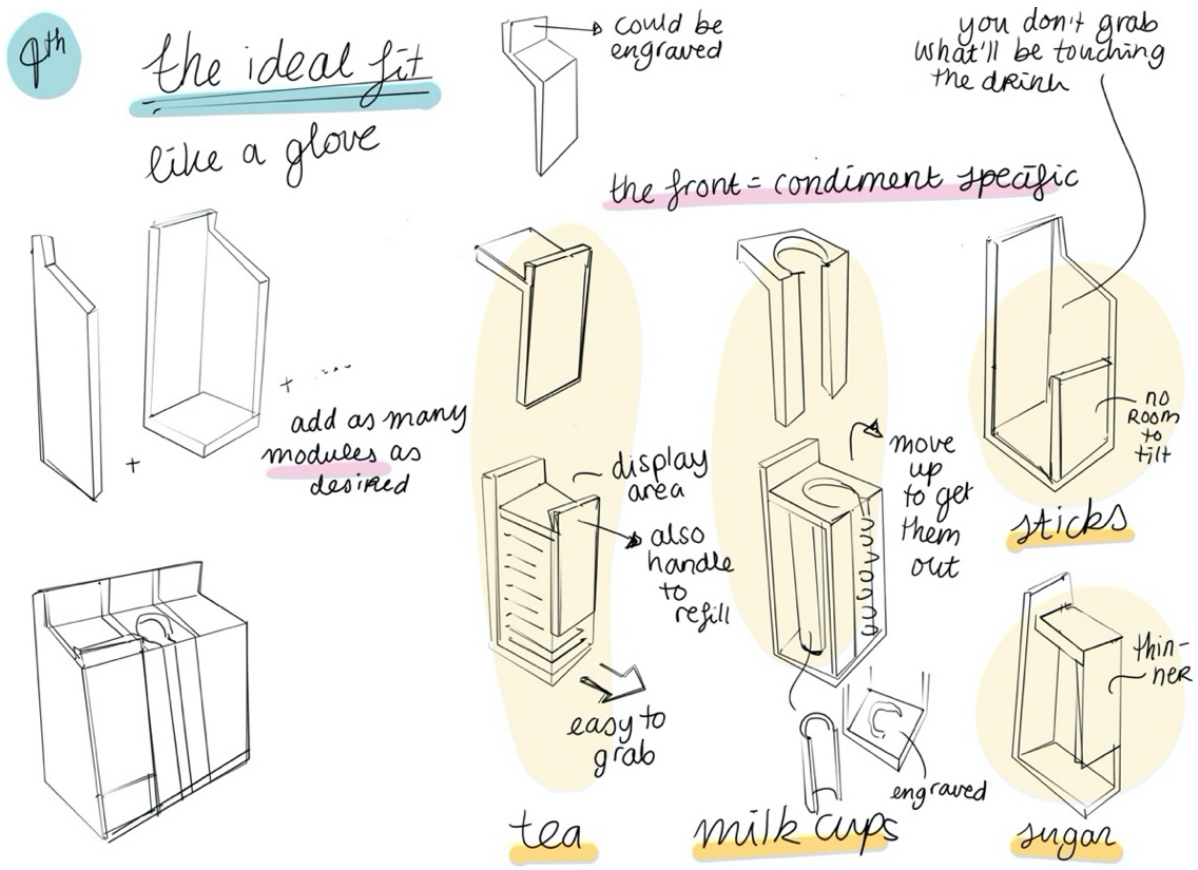


Description: This Do-It-Yourself (DIY) kit for condiment organization is based on the statement of MAAS that: "all corporates use different types and different amounts of condiments". This variety of orders requires flexibility in design. This kit contains vertical beams with holes, assembled baskets, pins and basket dividers. The vertical beams can be ordered in 3 different heights. Using the pins, the baskets can be fixated at preferred height creating a desired composition. Every basket comes with 2 drawer dividers than allow for compartment size flexibility within each basket. A brochure can be added to offer inspiration with build opportunities.

Pros:
(+) Allows flexibility, the proposal can consist of a brochure showcasing DIY assembly options. Similar to an IKEA manual.
Cons:
(-) All condiments are presented with the same angle > Perhaps the basket dividers should allow for positioning under an angle.
(-) As the wall height of the baskets is fixed, some condiments might turn invisible whereas others stick out a lot. This might appear chaotic.

CB feedback: "Speaking from experience; the baskets should be pre-assembled. Attaching walls that are as thin as these are going to be, can be quite a hazzle. That should not be up to the customer. [..] The beam + pin system would be best if store bought, there is no need to invent this system yourself. Also, considering the weight of the baskets, adding only beams on one side might cause the product to tilt."

4th idea. Fits like a glove (compartment)



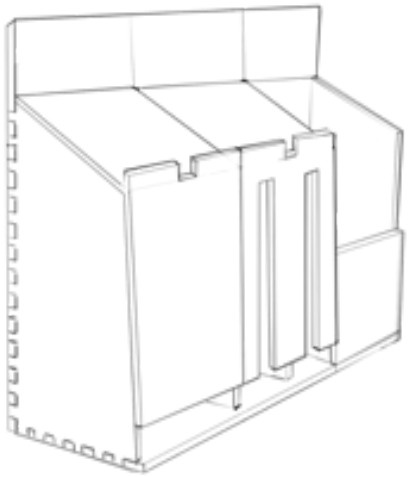
Description: This idea is based on the brainstorm session described in paragraph XXX. The manner of condiment picking as well as the preferred sorted orientation that is used, is based on these user insights. All sets start with a single wall and up to preference separate modulus can be added to the right side of the wall. The modules are available in 2 width sizes, the wider ones suit: tea bags and stirring sticks. Whereas the thinner version works best for the sugar sachets and the milk cups. Depending on the condiment that needs storage, a suitable front can be added. The tea and sugar fronts allow for sample flavors to be displayed at the top and the bags to be picked from the bottom side. The milk cups are ordered using a guidance slit to guide the milk cup lids. The sticks cannot fall down and are covered till a certain height, preventing users to unhygienically touch other people's stirring sticks.

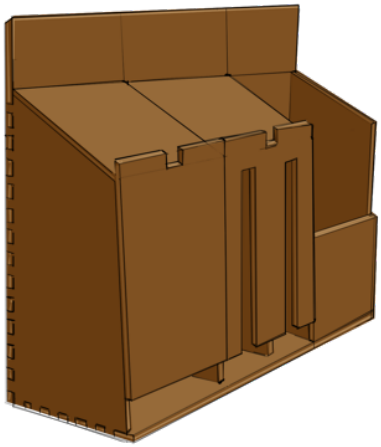
Pros:
(+) Condiment specific compartments based on user preference.
(+) Separate modules allows for smaller corporations to buy less than bigger ones.

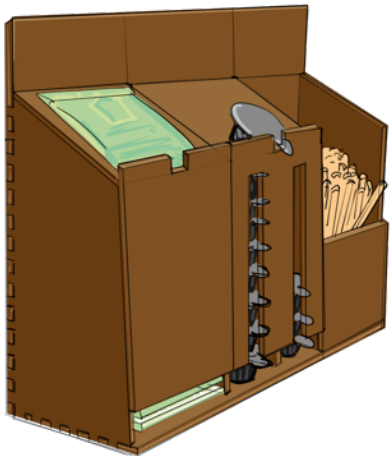
Cons:
(-) Once a front is ordered, the user cannot easily switch condiments per module.

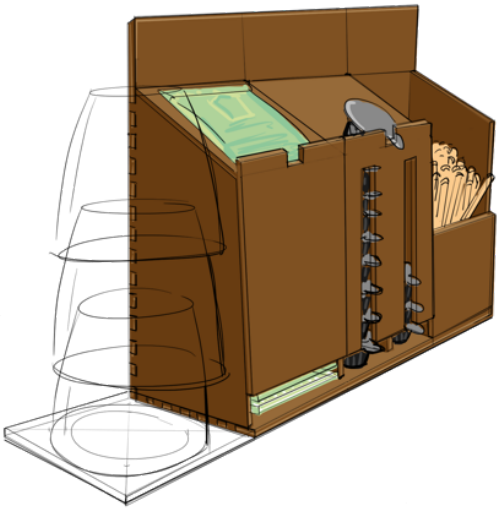
CB feedback: "This idea is based on the condiments the most and seems the most thought out. [..] Considering the production possibilities, it would probably be better to sell a set of 3-5-8 background modulus that are pre-assembled. The user can pick the fronts for themselves. To allow users to change their minds, the fronts should allow for condiment-specific-change'.

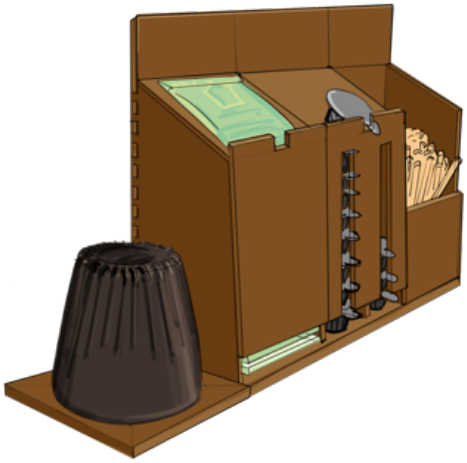
Appendix J. Conceptualization sketches

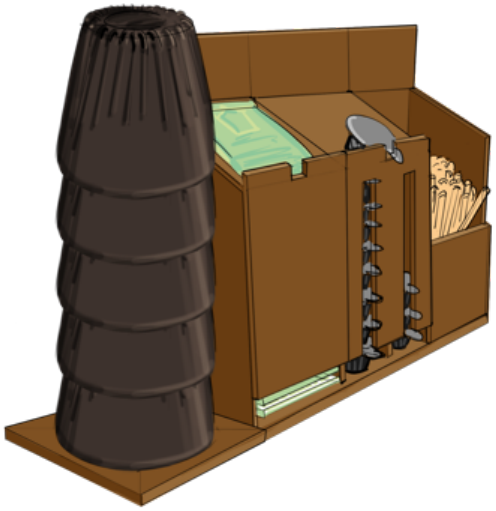


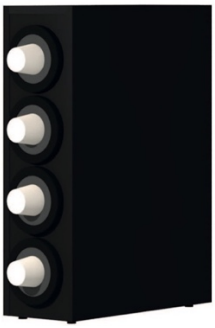












based on evaluation feedback

implement a holder for the lucky cup

⊕ no dust collection

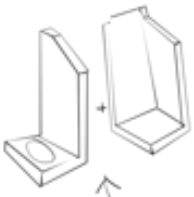
⊕ more surface to grab cup

⊖ dust collects

⊖ smaller surface

⊖ last one can be mistaken for dishes/dirty

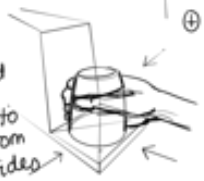
prevented with clear "parking spot"



implement in all "start - walls"

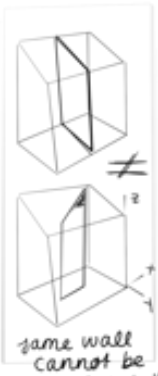
means they can only be placed on the sides

should leave room to grab from all sides

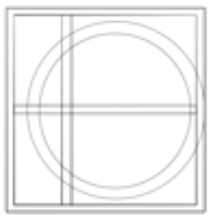


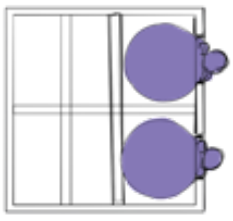
they're delivered pre-assembled

you add & choose the fronts



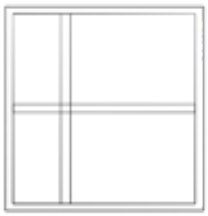
same wall cannot be used in both xz and yz direction



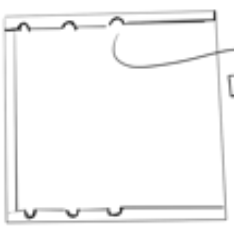


pull them out; should not pull out the next one too.

how to make 1 size fits all?

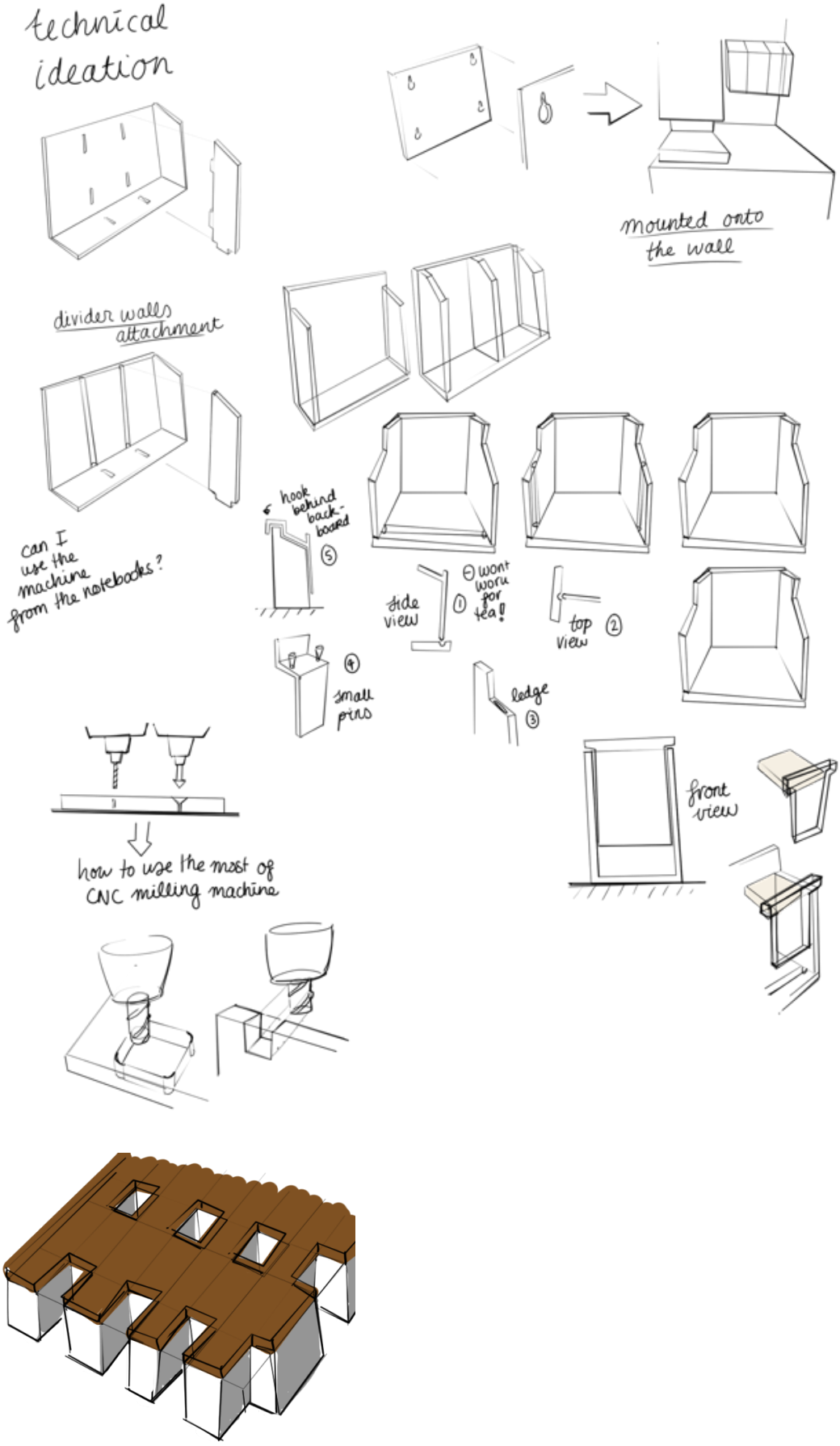


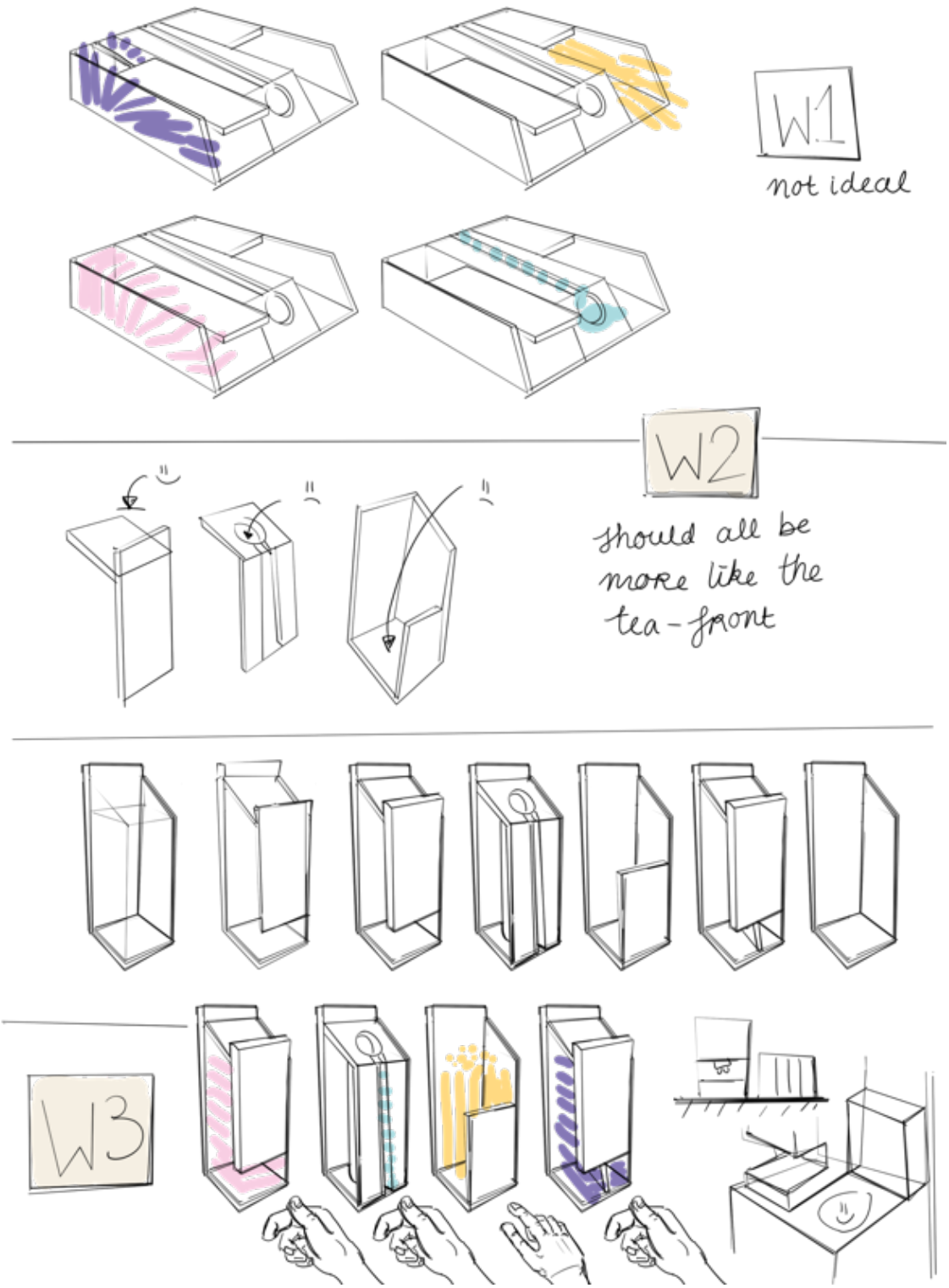
1x tea
1x sugar
2x milk



CNC

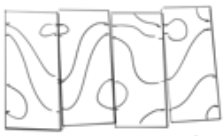
with a 4mm wall thickness how much of the lid is left to grab?


technical ideation
mounted onto the wall
divider walls attachment
can I use the machine from the notebooks?
hook behind back-board
side view
top view
small pins
ledge
front view
how to use the most of CNC milling machine


W1
not ideal
W2
should all be more like the tea-front
W3

design ideas

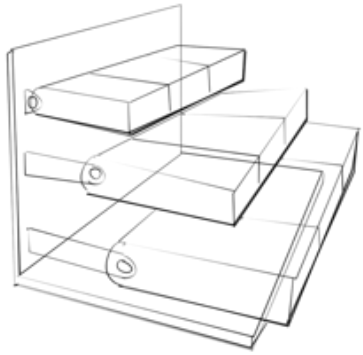
engraved patterns



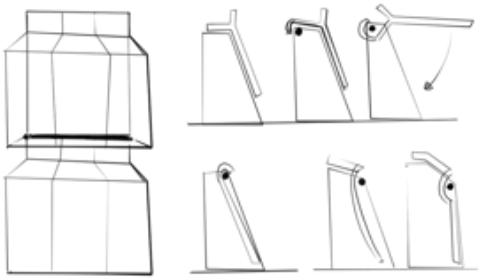
example order

⊕ emphasizes the modular freedom

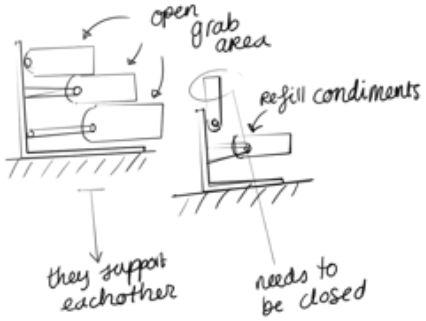
⊖ reduces focus on infographic information



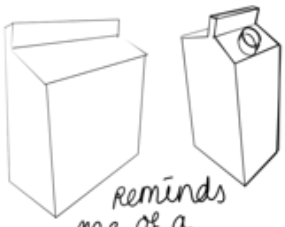
Rotate like drill-set



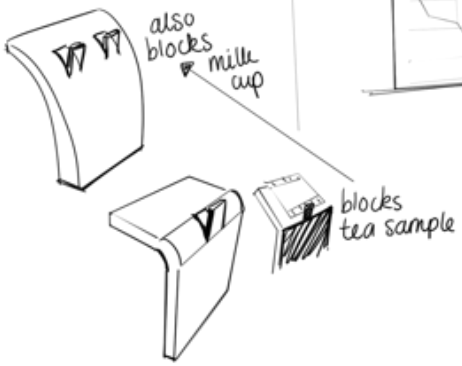
stacked like chairs

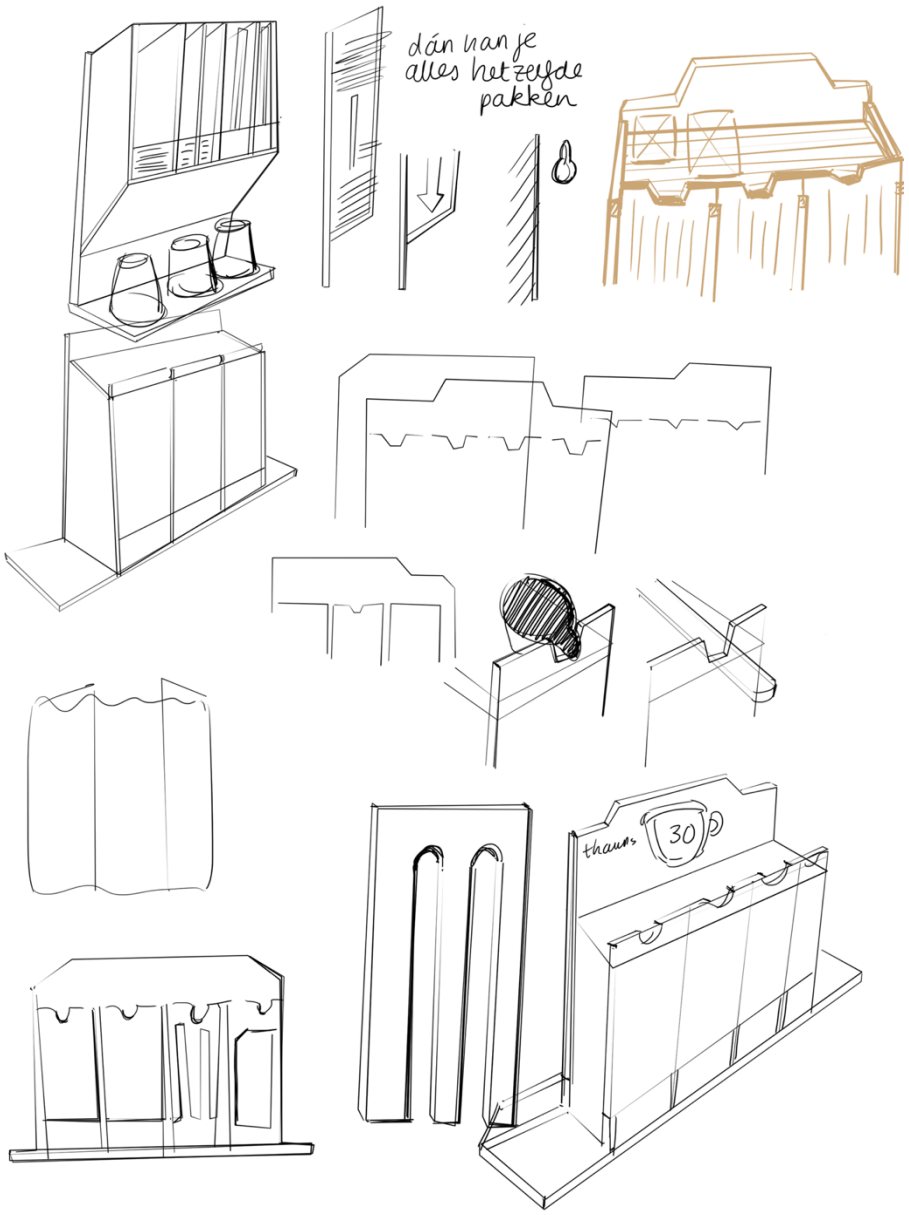


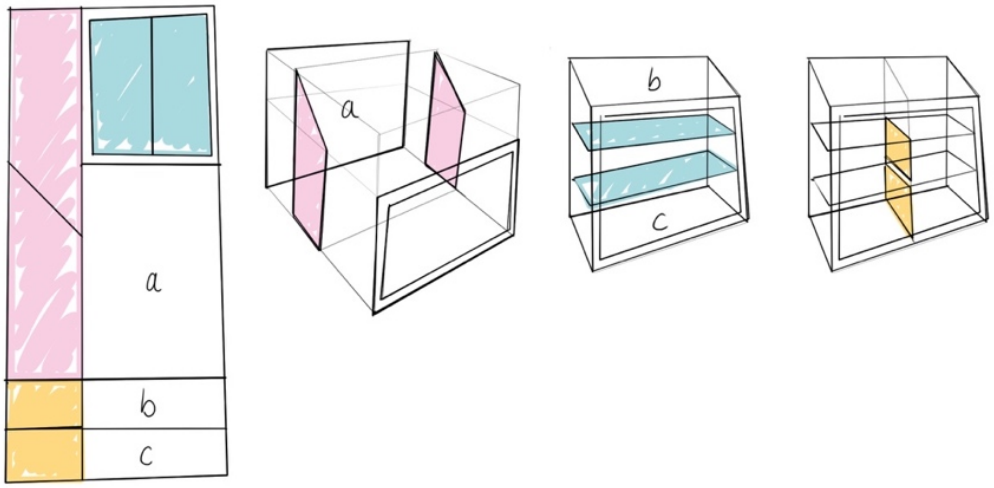
side panel

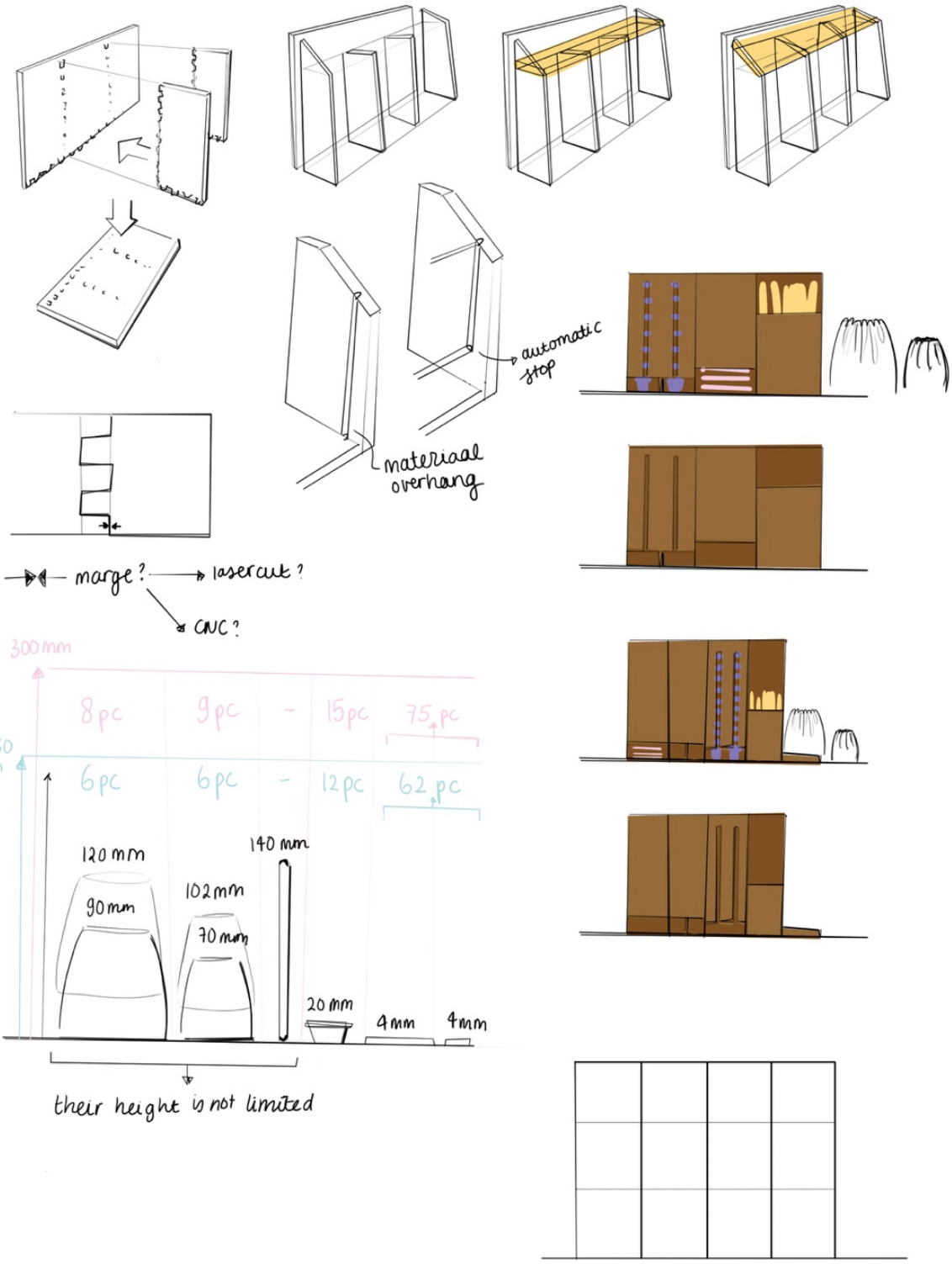


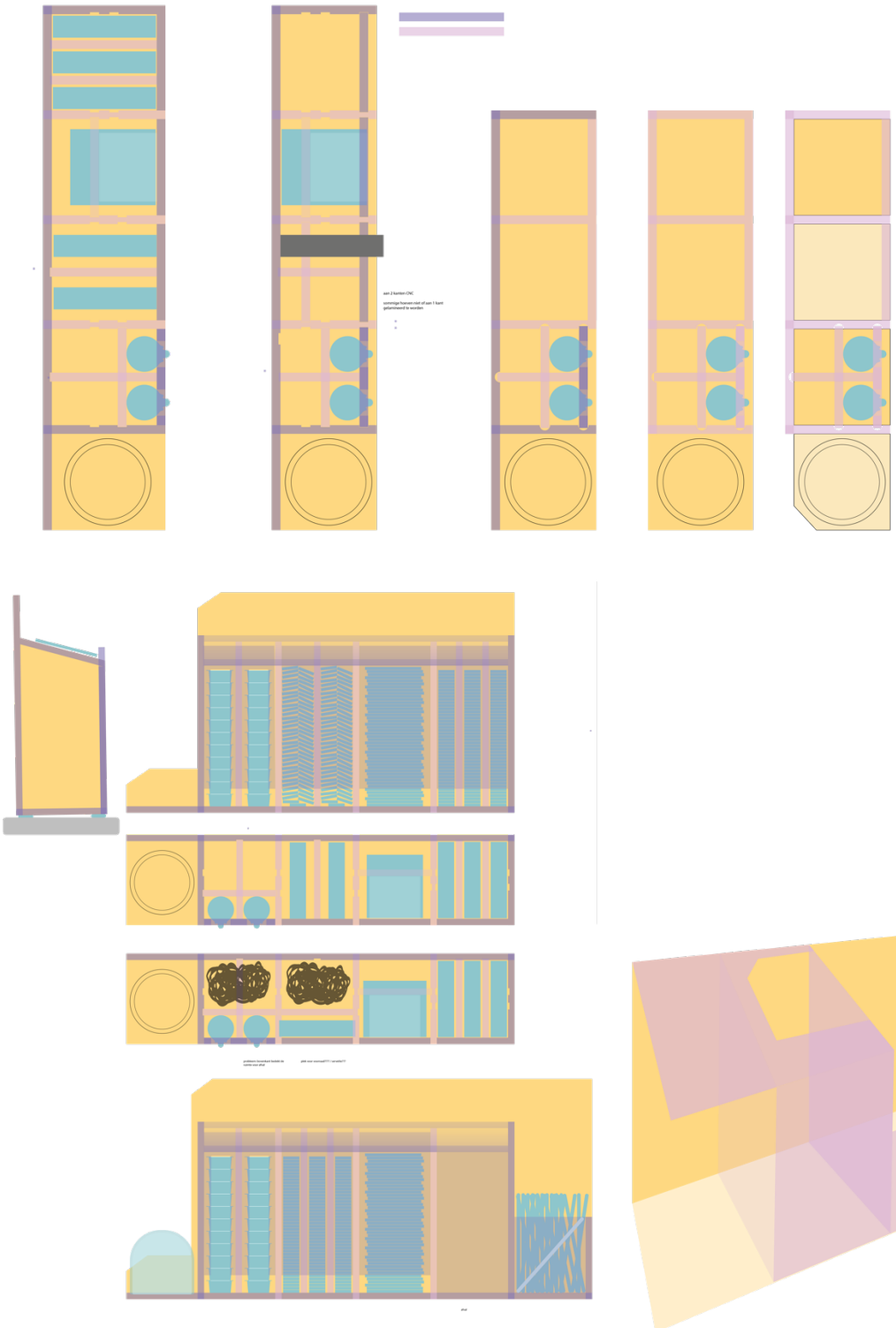
reminds me of a milk carton

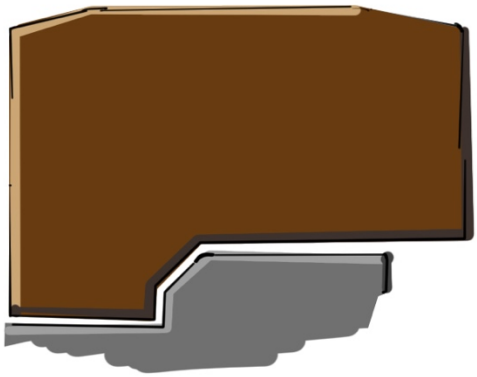


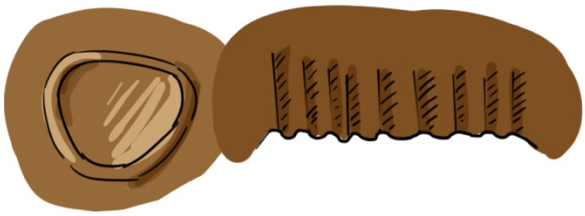

dán kan je
alles het zelfde
pakken
thaus
30

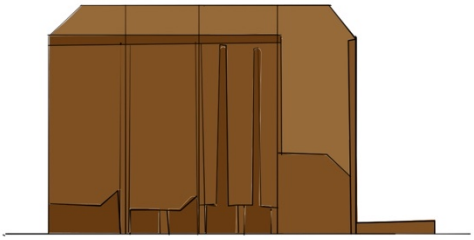

a
b
c
a
b
c

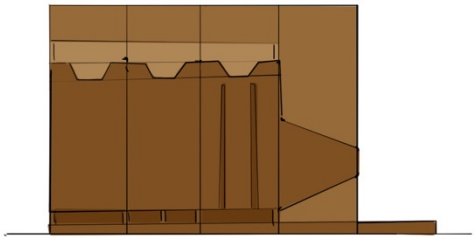

automatic stop
materiaal overhang
marge?
lasercut?
CNC?
300mm
250 mm
8pc
9pc
-
15pc
75pc
6pc
6pc
-
12pc
62pc
120mm
90mm
102mm
70mm
140mm
20mm
4mm
4mm
their height is not limited

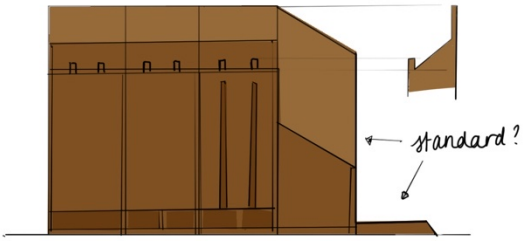


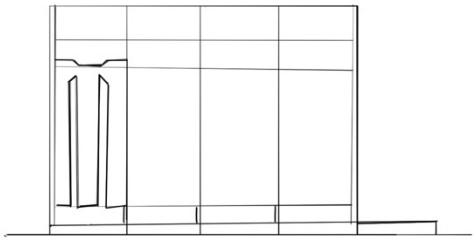


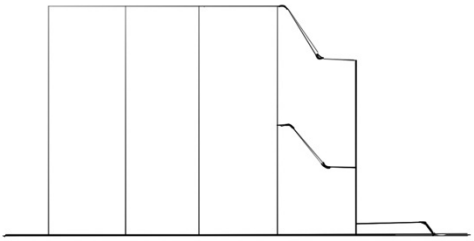


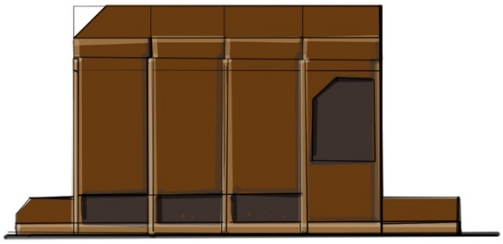


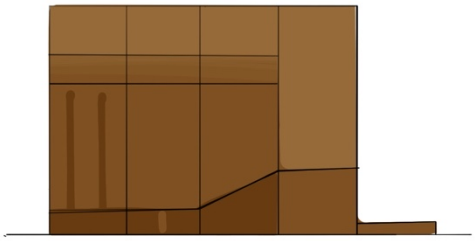



standard ?

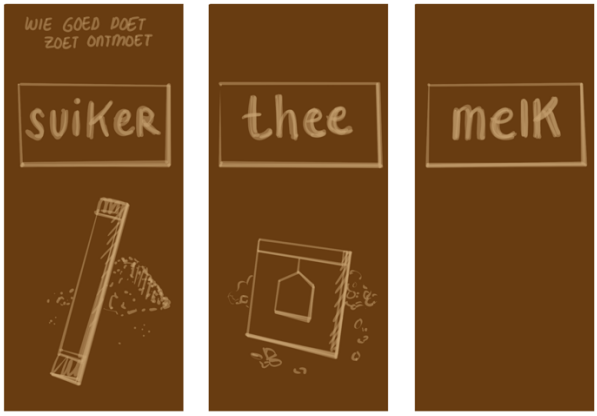









tea
sugar
milk
sticks

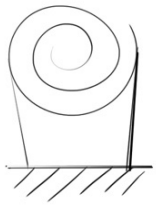

WIE GOED DOET
ZOET ONTMOET
suiker
thee
melk


TEA


30
thanks for helping
into this product

WASTE

waste to taste -



carbon captured coffee consumption

sharing = caring → especially if it's coffee

shared love for coffee

love for coffee

lovey coffey

min waste is taste
min is taste
minus

tasteful = tasty
wasteful = wasty

Let's get personal

energize with coffee
personalize with flavor

energiek met koffie

van koffie restantje
naar persoonlijke randje
- persoonlijk restrandje -

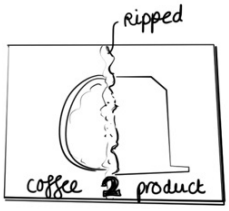
smaak = smaakvol = smakelijk

afval = afvalvol = afvallijk

koffie = koffievol = koffelijk
kovivol (als koffelijk)

KOVIVOL

plant-based delight



time to wake-up
conscious coffee

from coffee
because
it grows on
trees you know

that's what
I plant to do
-
how I plant it

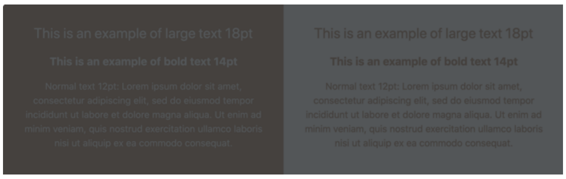
⇒ LETS PLANT THE FUTURE

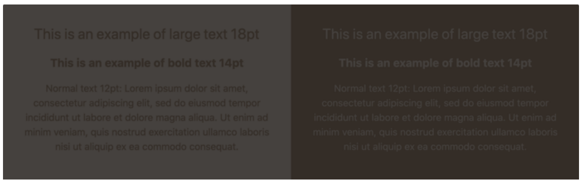
we'll help plant your day
with a cup of coffee

Appendix K. Contrast tests

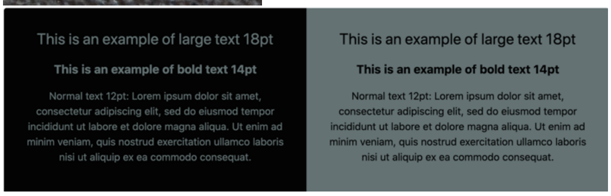
"Accessible = people with disabilities can equally perceive, understand, navigate, and interact" (W3C, 2010). Color codes are picked using a color picker and the contrast is measured (image-color, 2021).

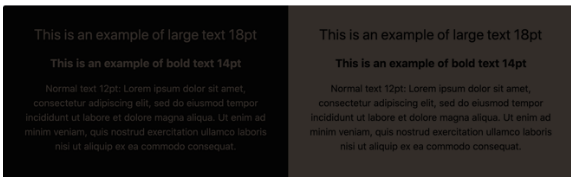
Test 1 and 2: CB1 + Resysta NoWood



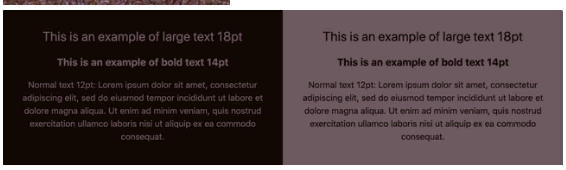


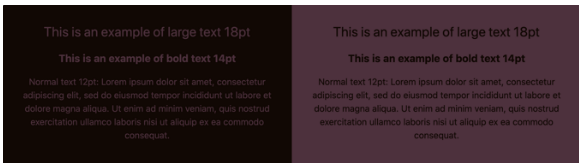
Test 3 and 4: CB1 + laser engravement





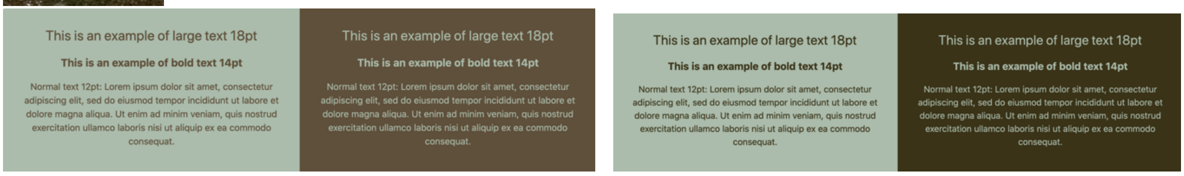
Test 5 and 6: CB1 + stamp





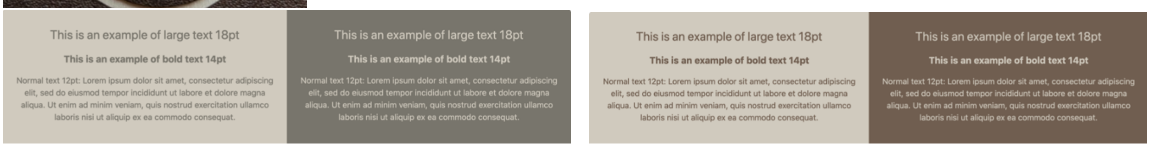
Test 7 and 8: CB1 coated with BioPin and washed + white paint

Test 9 and 10: CB1 coated with BioPin + white paint



Test 11 and 12: CB1 + white paint

Test 13 and 14: CB1 + plywood



	Sign	Background	Min. contrast	Max. contrast	Min. contrast	Max. contrast
			12 pt	12 pt	19 pt	19 pt
1	45413E [CB1]	535658 [Resysta NoWood light]	-	-	-	-
2	45413E [CB1]	342D27 [Resysta NoWood dark]	-	-	-	-
3	030303 [engraved CB1]	647273 [CB1; light]	-	-	+	-
4	030303 [engraved CB1]	332D29 [CB1; dark]	-	-	-	-
5	110804 [stamp]	6D5960 [CB1; light]	-	-	+	-
6	110804 [stamp]	4C313D [CB1; dark]	-	-	-	-
7	E7E9DD [white paint]	C2A88D [dishwasher CB1; light]	-	-	-	-
8	E7E9DD [white paint]	564D3F [dishwasher CB1; dark]	+	-	+	+
9	ABBCAC [white paint]	5F503C [coated CB1; light]	-	-	+	-
10	ABBCAC [white paint]	3A331A [coated CB1; dark]	+	-	+	+
11	EEF2F3 [white paint]	887160 [CB1; light]	-	-	+	-
12	EEF2F3 [white paint]	705E51 [CB1; dark]	+	-	+	+
13	D0CABF [plywood]	78756C [CB1; light]	-	-	-	-
14	D0CABF [plywood]	705E51 [CB1; dark]	-	-	+	-

Accessibility of communication.

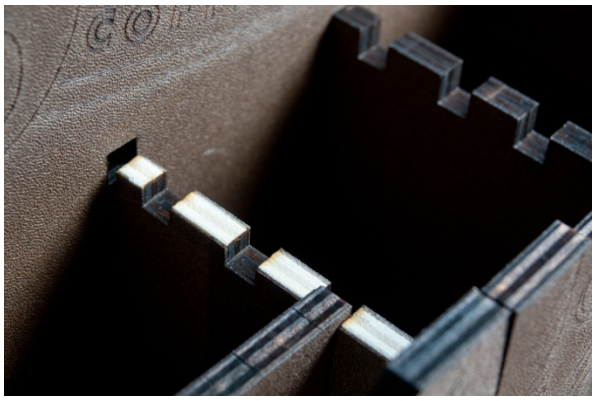
Appendix L. Prototype assessment

1. The engravements to locate the cups are not deep enough. The cups won't stay put.

2. The fronts move too much. Because of variations/tolerance they can rotate around the top part of the T-shape. Unfortunately, this means that the milk cups aren't as rigidly stacked as hoped.

3. The height of the gab, whereof the condiments need to be grabbed does not function as user friendly as hoped. It was planned to measure the appropriate height in an earlier prototype, but because the design had changed it was never finished. The earlier prototype had to be milled in order to place the fronts. The height and ease of use was guessed based on

4. The prototype panel was not big enough for all of the parts, one of the horizontal fronts was skipped. Also, the panel was displaced underneath the laser cutter with a deviation of approximately 3mm. This caused the tips of one of the middle walls to be cropped.



5. It was tested earlier if the CB1 laminate could be laser cut, to ensure that the model could be produced. However, now that two layers were used to laminate an 8mm plywood core, the bottom laminate gave some issues. The thermoplastic properties caused the laminate to melt in certain spots. While the rest of the panel was cut, the molten CB1 solidified closing up the cut. While removing redundant parts and severing the panel parts, the CB1 needed to be teared. This led to discolorations in a few spots.

6. The vertical wall divider does not perform well in its function to close of the dust slit. This needs to prevent the stirring sticks from falling out when the product is lifted, e.g. to be cleaned or refilled.

7. The number presented on the front, 30, does not actually resemble the number of cups' worth of SCG that is used inside this product. It was an old number that was put there by mistake. It should have said 44 cups.

Appendix M. Impact unprofessional testing

Since comparison makes up a big part of the physical assessments but not the theoretical ones, the impact of this inconsistency is estimated to be limited to approximately 37.5%.

All test results are based on theoretical assessment (circa 50%) and physical assessment (circa 50%).
Of the physical tests, about half are based on the application of coatings or adhesives, which are applied inconsistently. This accounts for approximately 25%. Of the remaining 25%, application did not play a part but an inconsistent photo set-up did. The tests consisted of the dishwasher test, scratch test, UV test and adhesion test. The conclusions for the dishwasher and scratch test are drawn from the pictures for comparison. This accounts for approximately 12.5% of the test results.

In total, this results in 37.5% of the tests.

Appendix N. Out-of-the-box suggestions

CoffeeBased 1
Starch based BioPolymer

CoffeeBased 2
Sugarcane based BioTechPolymer

Main drivers

(1) material selection

Laminate:
(+) thermoplasticized starch
(+) coffee
(-) unknown additives

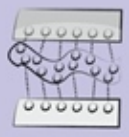
I. BioBased coating
(+) maintenance after 3 yr

II. FossilBased coating
(-) VOC's

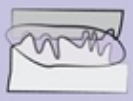
III. Glass sheet
(?)

Bio-adhesive
(!) no VOC's
(!) no fossil chemicals

Laminate:
(+) fermented degydrated polymerized sugarcane juice
(+) coffee
(-) unknown additives



I. Treatment + adhesives
(+) energy, expensive
(!) no VOC's



II. Platewelding
(!) no adhesives, no treatment

(2) product lifetime

Laminate:
(-) heat, liquid, UV, scratching, chemicals

Laminate:
(+) heat, liquid, scratching
(-) UV
(?) chemicals
(!) not yet extruded

(3) end-of-life scenario

Laminate:
(+) certified as biodegradable
(!) not an advantage unless disposed in nature

Laminate:
(+) chemically equal to fossil-based plastics therefore should be treated as such and be placed into the plastic recycling system
(+) recycling is better than incineration
(!) should not be incinerated

(+) advantage, (-) disadvantage, (!) noteworthy, (?) (yet) unknown

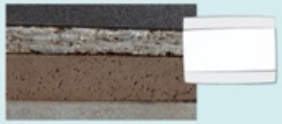
BioBased
Biomass based core

Recycled plastic
Fossil based core

Main drivers

(1) material selection
(2) product lifetime

I. Solid wood
(-) price: expensive
(+/-) strong/stiff



II. Fiber board *
(+) price: cheap

III. Plywood *
(+) cheap

IV. Honeycomb cardboard *
(+) easy to bend
(-) needs
(!) with or without extra layers

V. Reinforced with fibers *
(+/-)

VI-X. BioPlastic versions of conventional plastic options*
(+/-)

I. Solid layer
(-) shrinkage, heavy, expensive
(-) inj. mold = expensive, limited volume options

II. Different polymer layers
(-) hard to recycle

III. Honeycomb layers
(+/-)
Example: rPET by XXX
Professional plastics:
PolyCarbonaat, density: 1.2 gm/cm3

IV. Plastic with fibers
(-) Expensive, time consuming
(-) hard to recycle

V. Sandwich with foam
(+/-)

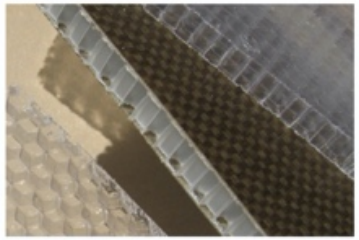
(+) advantage, (-) disadvantage, (!) noteworthy, (?) (yet) unknown

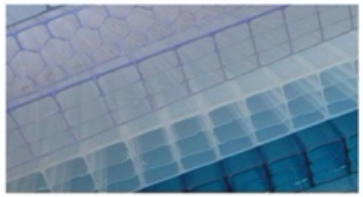
VI. BioPlastic versions *
e.g. PolyLactic Acid (PLA)

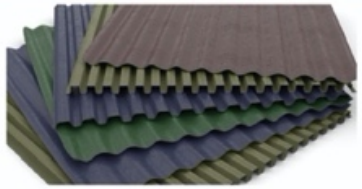
I. Solid PLA
(-) difficult manufaturing, expensive molds or unequal shrinkage if extruded.

II. Different layers
(-) hard to recycle

III. Honeycomb layers
Example: Econcore with PLA

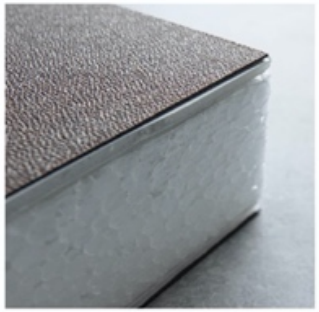






IV. Plastic with fibers
(-) hard to recycle

V. Sandwich with foam
e.g. BASF's biodegradable polymer ecoflex and polylactic acid



*(!) no formaldehyde, no VOC's

(+) advantage, (-) disadvantage, (!) noteworthy, (?) (yet) unknown

Insights:
Recycled plastic as well as BioPlastics are not commonly used as a core material as such are considered too innovative to be accepted by the end users. CoffeeBased prefers to enter the furniture panel market with a core that's similar to the standard but is innovative by its choice of laminate. Once their market share has grown, more innovative cores can be considered.

D1: Color: Recycled plastic gets more expensive after each recovering phase. Sorting the material by color is thus more expensive. As the material would be covered by laminate anyways, the costs are prevented.

F1: Weight: A panel made from recycled HDPE would way more than a panel with the same volume made from wood. Density HDPE = 950 kg/m3. Density multiplex 9 ply Poplar = 500-700 kg/m3.

F2: Form Freedom: The panels are sold to designers who build furniture with them. Plastic needs to be molded and molds are expensive. To allow different shapes and sizes, the mold would need to be adjustable, or the designer would need to be responsible for reshaping the panel.

F3: Machines: Furniture makers' equipment is based on woodworking. It is likely that different panel- and furniture manufacturers own different machines. It is recommended to explore the available options within the Dutch borders.

Reduced weight solutions
Options for reduced weight include the lightweight center layers used inside sandwich panels, e.g. foam, corrugated and honeycomb layers.
(-) Recycled plastic can contain contaminants which could hinder proper extrusion.
(+) EconCore sells honeycomb structures made from recycled PET, proving that it is possible.
(+) EconCore also sells the same structure but made from PLA, but this product was discontinued due to low market demand.

Appendix O. Design Brief

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name	Vester 4374
initials	I given name Indy
student number	4363809
street & no.	-
zipcode & city	-
country	-
phone	-
email	-

Your master programme (only select the options that apply to you):

IDE master(s): ★ IPD ( ) DfI ( ) SPD

2nd non-IDE master:

individual programme: - - (give date of approval)

honours programme: ( ) Honours Programme Master

specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	Jan-Carel Diehl	dept. / section:	SDE / DfS
** mentor	Martien Bakker	dept. / section:	SDE / PAD
2nd mentor	Lisanne Addink – Dölle		
	organisation: CoffeeBased		
	city: Rotterdam	country:	the Netherlands

comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduation

TU Delft

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair Jan-Carel Diehl date 31 - 08 - 2020 signature jdiehl Digitally signed by jdiehl Date: 2020.09.01 14:37:26 +02'00'

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 30 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 30 EC

List of electives obtained before the third semester without approval of the BoE

★ YES all 1st year master courses passed

NO missing 1st year master courses are:

name J. J. de Bruin, SPA-IO date 02 - 09 - 2020 signature J. J. de Bruin, SPA Digitally signed by J. J. de Bruin, SPA Date: 2020.09.02 09:34:17 +02'00'

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ★ APPROVED NOT APPROVED

Procedure: ★ APPROVED NOT APPROVED

comments

name A. Huwae date 15 - 09 - 2020 signature A. Huwae Digitally signed by A. Huwae Date: 2020.09.16 08:59:00 +02'00'

Initials & Name I Vester 4374 Student number 4363809

Title of Project Furniture panels out of CoffeeBased material; used for condiment rack

Personal Project Brief - IDE Master Graduation

TU Delft

Furniture panels out of CoffeeBased material; used for condiment rack — project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 31 - 08 - 2020 — 05 - 03 - 2021 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Dutch waste incinerators burn 300 million kilo of coffee grounds annually accumulated by the Dutch population. Product manufacturer CoffeeBased saw potential to harness this waste stream and started to collaborate with coffee supplier MAAS and garbage retriever SUEZ to retrieve coffee grounds from corporations with high coffee waste production rates (CoffeeBased, 2020).

The company
CoffeeBased manufactures products made from 100% biobased plastics derived from the retrieved coffee grounds (Addink-Döle, 2019). In addition to promoting circular economy, this upcycling also helps minimize material energy loss by incineration, decrease waste accumulation and reduce material resource extraction as the bioplastics can replace hazardous synthetic materials (Vinod, 2020).

The material
There are 3 types of CoffeeBased bioplastics, the first is suitable for extrusion to produce sheet materials, e.g. used for notepad covers [see figure 1a]. The second and third are both meant for injection molding distinctive by their non-food and food related purposes (e.g. plant pots and coffee cups respectively).

Research is being done within the company to enhance the material properties of the CoffeeBased sheet material (in Dutch: folie / vellen). The sheets can either be thickened (e.g. used for coffee machine fronts) or be used as lamination covering a stiffer base material like an eco-board (e.g. for furniture panels). Coffee supplier MAAS is provider of all-inclusive coffee experiences and has requested that CoffeeBased produces furniture panels in order to produce a coffee table, of which a first edition is already built [see figure 1b]. To assist the latter research development at CoffeeBased, a collaboration by means of this graduation project has been agreed upon and can be described in two phases as follows:

Phase 1: Optimization of laminated furniture panel
Several initial furniture panels are already produced, a more sustainable optimization is requested. The research would consist of identifying and testing attachment methods, such as adhesives, and property enhancements, e.g. making it scratch resistant, waterproof and heat resistant. Another requirement of the project would be to make it suitable for industrial production. All proposed adhesives, surface treatments and added materials should be in line with the company's vision and aim to produce biobased (and if possible) circular panels.

Phase 2: Implementation of furniture panel in a condiment rack
Besides the coffee table, MAAS desires a designed condiment rack, see figure 2a for an example. The product is required to hold several coffee flavoring additives and should be produced using the laminated furniture panel. A first orientation and coinciding set of drawings is already produced by an intern prior to the graduation project. The product can be simple and functions also as confirmative example of the future prospects of the CoffeeBased furniture panels.

The designed condiment rack is aimed to be implemented in MAAS' coffee experiences and thus the collected coffee grounds will be returned to its place of origin, namely the corporates' coffee corners. Closing the loop on corporates coffee usage with an all-inclusive biobased coffee experience, filled with coffee.

space available for images / figures on next page

Initials & Name I Vester 4374 Student number 4363809

Title of Project Furniture panels out of CoffeeBased material; used for condiment rack

introduction (continued): space for images

figure A

figure B

image / figure 1: CoffeeBased's sheet material (a) and furniture panel (b)

figure A

figure B

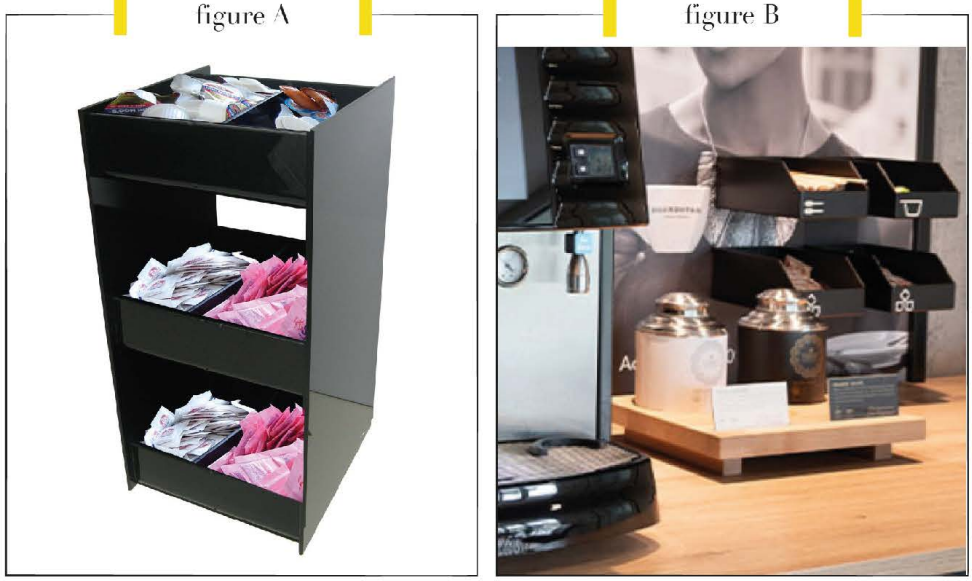


image / figure 2: Condiment rack example google (a) and MAAS' current condiment rack (b)

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

This graduation project will start with the optimization of CoffeeBased's furniture panels after which the panel is implemented in a condiment rack design. Creating biobased furniture panels that can withstand large forces and exposures to both heat and liquid from coffee (spills) as well as scratches from everyday use, requires material testing.
// Project management method: reflecting every week by asking: 'what did I achieve, what do I want, how will I do it'.

// Phase 1: panel optimization method: assessment by EcoDesign checklist and Triple Bottom Line method
1a) Research CoffeeBased sheet material and existing furniture panels and their material properties.
1b) Make a miniature test production set-up of material testing
1c) Research, test, simulate and validate the following:
- combinations of layers that can withstand large forces, using the CoffeeBased's sheet material as lamination
- attach possibilities of the different material layers, e.g. by means of adhesives
- protective measures against outside interferences by means of a coating or surface treatment.

// Phase 2: condiment rack design method: basic design cycle using rapid prototyping and SolidWorks for simulations
2a) Analyze: Material: Translate the panel properties into design opportunities.
2b) Analyze: Product: Creative session with MAAS on product requirements e.g. compartment sizes, total volume and (de)-assemble methods) and envisioned user scenario's.
2c) Synthesize: Design a condiment rack based on the results from 2a and 2b, using rapid prototyping.
2d) Simulate: Iterate and prototype the final design using the furniture panels.
2e) Evaluate: Using the ecoDesign checklist
2f) Decide: Give recommendations for an industrialization plan, including price analysis.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Research, test and validate solutions to reach a sustainable optimization of the furniture panel made (partly) from CoffeeBased sheet material. The optimized panel functions as basis for the design of a condiment rack.

Aim to create a functional furniture panel, using the coffeebased material to harness the waste stream of coffee grounds. A list of test results will indicate if material combinations and suggested biobased materials have potential for further use within CoffeeBased. A small set-up mimicking industrial production methods will be made to ensure qualitative data from the tests. The optimized panel will open up future opportunities to use the CoffeeBased materials in furniture.

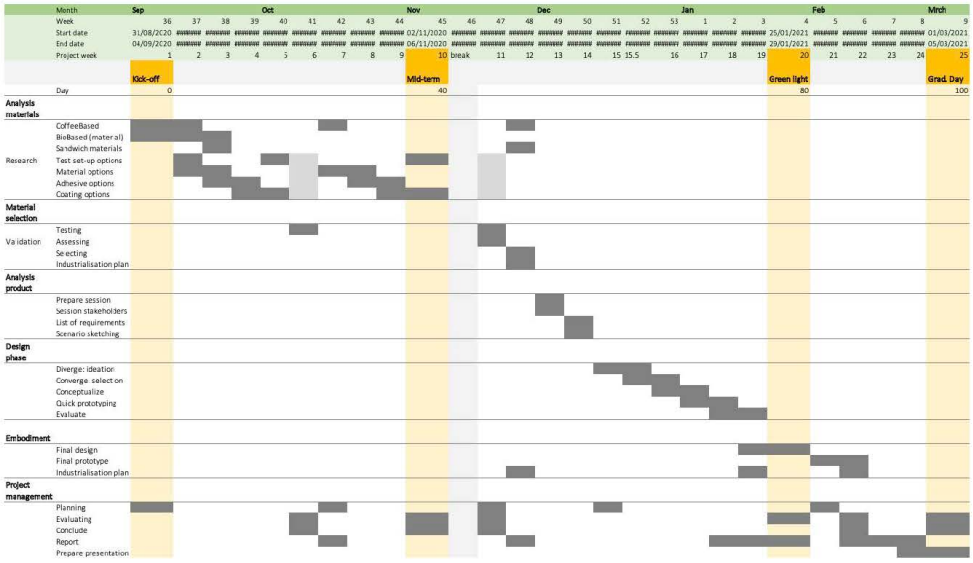
The condiment rack that is to be designed is requested by partner and coffee supplier MAAS as market demand is predicted. It will showcase the panels by means of a functioning prototype and recommended industrialization plan.

Using the 100% biobased material in a design and acknowledging the worth of waste will hopefully inspire designers to do and think likewise.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 31 - 8 - 2020 5 - 3 - 2021 end date



- (Literature) analysis of materials
- Iterative loop:
// Analysis possible materials
// Build test set-up, able to produce multi layered materials
// Test different material combinations
// Evaluate properties of combinations using tools at PMB or other facilities
- Analysis product usage
- Ideation
- Conceptualization
- Conclusion

Due to a history of getting panic attacks due to high stress levels, I have decided to graduate by studying 4 days a week. Furthermore, one week off after the midterm presentation is planned to ensure positive mental health during this graduation project. Celebrating Christmas and New Years accounts for one week off, 4 days in total.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

Before starting my master of Integrated Product Design I started to develop a deep longing to help, may that be helping the environment, humans or animals. During my master I followed my elective courses at Aalto University in Finland enhancing my appreciation for nature and improving upon my English vocabulary. I also did an internship at WASTE, looking at product development using waste plastics in low-income countries. During the internship my disapproval for multilayered and one-time-use plastic packaging grew and therefore I look forward to exploring towards a more sustainable version of multilayered panels without the harmful chemicals. After brainstorming on potential companies and/or cases for this graduation thesis the direction of designing medical devices, tools for people in low-income countries, food packaging alternatives and biodegradable plastics replacing oil based plastics have come up.

CoffeeBased is a subcompany of VerdraaidGoed, who aim to reduce environmental impact by transforming old products/materials from waste streams into new products. As someone who often wanders through second-hand stores hoping to buy old stuff in need of upgrading, this company felt like a good match. Next to this, I have been using my own coffee grounds to grow mushrooms using the Rotterzwam DIY-kit. And now I have come to learn that the coffee grounds left unused by CoffeeBased go directly to the Rotterzwam collective as well. As a product designer making substantiated decisions regarding material selection is crucial as it could have major impact on preventing natural resource depletion, waste accumulation and environmental pollution. With these design decisions we can allow customers to have positive impact at household level. Exploring a specific biobased material and therefore gaining more knowledge on sustainable alternatives for plastic seems like a good way to help achieve that.

During the extent of this project I wish to improve my analytic abilities and project management skills. Besides, I would also like to:
- recap my Advanced Prototyping knowledge and put it to use.
- learn more about material exploration by (literature) research and testing
- look at how to set up an industrialization plan
- reflect on my design abilities, especially in a corporate context with multiple stakeholders

As the condiment rack is requested by MAAS, the product will not be designed just for the sake of designing, but to comply with the demand. Therefore, the project has real potential to reduce waste by reusing the renewable coffee ground waste.

In conclusion:
I aim to explore a biobased material, test its properties (e.g. scratching, heat and liquid impact), have a stakeholder creative session and simulate ideas via SolidWorks or quick prototyping. All complying with the following ambitions:
1) learn how to retrieve knowledge on [biobased] materials and their properties by testing
2) learn how to translate researched solutions into design boundaries and opportunities for product design
3) learn how best to brainstorm with several stakeholders and visualize their imagined user scenarios
4) learn how to use quick prototyping / SolidWork skills to validate concepts
5) learn how to make a professional final prototype

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Addink-Döle (2019). Cherish your trash. Retrieved from: https://www.youtube.com/watch?v=nr7RnE8dH3Y
Coffeebased (2020). General information. Retrieved from: https://www.coffeebased.nl/
Vinod (2020). Renewable and sustainable biobased materials: An assessment on biofibers, biofilms, biopolymers and biocomposites. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0959652620310258

Initials & Name I Vester 4374 Student number 4363809

Title of Project Furniture panels out of CoffeeBased material; used for condiment rack

Let's not waste your coffee waste!

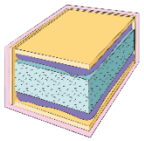
Sustainable material research

CoffeeBased is a material- and product manufacturer, that uses low-value spent coffee grounds (SCG) to make high-valued products. On their request, their laminated furniture panel is optimized. Because, the laminate discolors and distorts when in the desired user context. Besides, except for the laminate, other components have not been selected on their sustainable character. Thus, a panel with better context resistance and sustainable value is requested.

from panel

Panel proposal

Bound by the desires of the end user, processibility of the manufacturing facilities, material compatibility and the resources available to CoffeeBased, market research was conducted. Four panel concepts are proposed panel concepts, each with its own (sustainable) advantages. Final recommendation depends on the priorities of the end user. For now, the panel with the highest increased waste content is considered most suitable to the thesis, called: **'All aboard, the EcoBoard'.**



All aboard, the EcoBoard!
- Clear lacquer as coating by BioPin
- BioComposite laminate by CoffeeBased
- BioImpact adhesive by Canect
- EcoBoard core by EcoBoard International
- Edge band from CB1 by CoffeeBased

Context resistance

A BioPin coating is recommended to be used until another CB material is developed and tested for laminate suitability. It offers protection from impact caused by heat, water, cleaning chemicals and sharp objects. The development of an edge band is incorporated in the concept, because it would enhance the aesthetic appeal of otherwise less attractive core materials.

Sustainable value

The sustainable requirements were selected based on the annotation that furniture panels in the Netherlands are incinerated[1]. Thus, the proposed panels are selected to be 'okay to burn'. The proposed panel has a **83% waste content increase** as well a **biobased content increase of 12%**, this while providing a potential **VOC emittance reduction of 1%.**

to product

Condiment organizer

A condiment organizer is designed, with the function to orient and display additives for coffee machine beverages, called condiments. Unfortunately, the necessary manufacturing method prevents the implementation of the optimized panel's EcoBoard and edge band. Thus, no-added formaldehyde plywood is used as core instead.

Pre-assembled back frame

For user convenience, the back frame of the design is pre-assembled before delivery. To offer options, these are available with 3, 5 or 7 compartments.

Selection of condiment fronts

Condiment specific fronts for tea bags, sugar sachets, milk cups and stirring sticks can be selected during purchasing. With their uniform fit, they can be switched at any given time.

kovivo

The condiment organizer is called "**Kovivol**", referring to the Dutch: "full of coffee". The appearance corresponds with the other coffee corner products sold by CoffeeBased. By purchasing a Kovivol with 7 compartments, users help save SCG from **44 cups of coffee**!

Indy Vester
Sustainable material research: Panel to Product
25th of March 2021
Integrated Product Design

Committee J.C. Diehl
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Company CoffeeBased
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