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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

Figure 04.2

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 mangle

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

Figure 06.1

Figure 06.2
07. Manufacturing
Mold milling

08. Manufacturing
Melting CB2 granulate + oven
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
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 ground 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

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)
A1. Material properties - density
Pieces of LDPE, HDPE and CB1 are put into a glass of water. The LDPE floats on top (0.92 g/cm^3) and HDPE just underneath (0.96 g/cm^3) (figure A1.1). CB1 sunk to the bottom straight away (1.2 g/cm^3) (figure A1.2). Makes sense as the density of water is 1 g/cm^3.

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

A3. Material properties - water + soap

Figure A1.1  Figure A1.2

Figure A2.1  Figure A2.2

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.

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 circles are made using the scratch test with and without a brick respectively. The blue circles point out a scratch made by a more blunt object (figure A5.2).

A6. Material properties - Plastic Scanner results

A7. Material properties - Wetting angle
oil droplet 7.1
water droplet 7.2
A8. Material properties
Coffee machine setup
Set up

A9. Material properties
Coffee machine setup
Discoloration

A10. Material properties
Coffee machine setup
Distortion

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).
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). Duct tape did manage to stay adhered to the CB1 laminate during the sandblasting (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 signature look, logo's or even statements if only the stamp is elaborate enough. XXX Also a heated button was used (figure B2.2).

**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, maizeena and iodium, was used to paint the CB1 laminate darker (figure B3.1)

B3.2 Tea

**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).
B5. Surface modification -
- laser cut
Logo’s
B5.1
B5.2

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

B1. Surface modification -
sand blasting

C1. Shape modification - laser cut
Patterns till the edges
C1.1
C1.2
C2. Shape modification - laser cut
Patterns without reaching the edges

C2.1
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 heated, 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

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

C8.1 direct heat
C8.2

C9. Shape modification - hot
By melting in a pan

D1. Attachment methods
D2. Attachment methods
Staples - cold

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 Pressurized with laundry mangle
E1.3 and E1.4 the laundry mangle in use

Figure E1.1
Figure E1.2
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.

E3. Adhesives
Sheet press

Sufficient method to apply equal distributed pressure to large panels during curation of the adhesive.
E4. Adhesives
Biolimpact Canect
Dishwasher test

Left is Biolimpact, right is wood glue.

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

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

F1. Coatings
Traditional fossil-based coatings
Scratch impact

In Dutch:
F1.1 Parket lak
F1.2 Result
F1.3 Blanke lak
F1.4 Result
F2. Coatings
BioPin coating

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

F2.3 Before dishwasher test
F2.4 After dishwasher test
- Left: non-coated
- Right: coated

F2.5 Scratch impact without coating
F2.6 Scratch impact with coating
- Left: With brick
- Right: Without brick

G. Cores
Cardboard honeycomb

G1.1 Before laundry mangler
G1.2 After laundry mangler
G1.3 Problem: too much pressure
G1.4 Problem: unequal distributed pressure

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

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

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.
G2.3 ECOR laminated with CB1 laminate

G2.4 ECOR compared to Resysta NoWood and EcoBoard

G3. Plywood Bending

G3.1 The aim: picture from the internet.

G3.2 Failure to reproduce. Using a saw.

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

G4. Resysta NoWood

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

G4.2 Top: Sanded
G4.2 Bottom: Not sanded
Molding by heat

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

Laser cut engravement

G4.5 Flame ignition
G4.6 Result
Sides: charred, like MDF
Orange dust: unknown

Dishwasher impact

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

Dishwasher impact

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

KEEP THE CONDIMENTS AT THE FRONT

SPRING

ANGLED PLATFORM
SHOW SUSTAINABLE CHARACTER

- Clearly know where renewable EG MULLTIPLEX
- COL FOR SUSTAIN THE VOLUME EFFECT

COLOR DIFFERENCES

EASY TO REASSEMBLE

SYMPATH

IPUC

CLOTHED

GREEN DREAM

33
Clusters

- Uniform shape
- Square shaped
- Organic
- Separate baskets
Competitor products similar to the clusters
Separate ideas
How-to questions

How to use the material tests

discolorations

typically coffee based

typically resysta

laser cutting is easy

thermoplast

feels compatible to glaze condiments but = more chaotic

can be thermoformed

laser engraved cannot go directly onto the resysta but onto the laminate

Typically coffee based
How to implement stakeholder input?

Coffee-based, Maas, Coca-Cola.

Not too chaotic.

Uniform front, cover condiments up.

Different orders, infill.

Support, user options.

Table version.

Easy to clean.

Don't let dust build, "gap".

Display for cups?

How not to use a regular hinge?
HOW TO DESIGN SUSTAINABLE

1. Use sustainable materials
2. Use what is already available
3. Reduce transport

Reuse the molds
- cups
- plantpots
- extruder melt sheet

Add to shapes
- universal connector piece

Flatten packaging
- shape of a bean

DIY assembly
- laminate
- slip practically invisible if not in use

Take products apart
- cut
- saw
- laser cut

Reshape products
- create small edge
- use details as benefit

Combine products

Watch out for cheap look

Watch out for quality look
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 (1 male 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”
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

- Stirring sticks
- Orientation
- Grab spots
  - Touches your drink
- Teabags
- Milk cups
- Sugar packets
"the flavor should be visible"

"preferably these are ordered & facing me"

"should be hygienic; this will touch my drink"

"these can be chaotic"

- tea
- a lid
- adjustable gear
- do not fall out
- open to fill
- Can milled
- tea cups
- tea
- milk
- some sides
- if it's twisted 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 focuses 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.”
**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 hassle. 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.”
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
- Smaller surface
- Last one can be mistaken for dishes/food

They're detailed pre-assembled; choose the fronts. How to make 1 size fits all?

- 1x tea
- 1x sugar
- 2x milk

Same wall cannot be used in both x2 and y2 direction.

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

With a 4mm wall thickness, how much of the lid is left to grab?
technical ideation

divider walls attachment

can I use the machine from the notebook?

how to use the most of CNC milling machine

mounted onto the wall
W1 not ideal

W2 should all be more like the tea-front

W3
design ideas

- engraved patterns
- emphasizes the modularity freedom
- reduces focus on infographics information

[Diagram of stacked like chairs]

Rotate like drizzle set

[Diagram of open grab area and refill condiments]

[Diagram of stands supporting each other and needing to be closed]

[Diagram of side panel]

blocks tea sample

[Diagram of also blocks milk cup]

reminds me of a milk carton
dán van je alles het zegde pakken.
TASTE

Waste to taste

- min. waste in taste

Plant-based delight

Time to wake up conscious coffee

Let's get personal

Energized with coffee, personalize with flavor

Koffie met koffie

Smaak + smakelijk
Aroma + aardig

Koffie = koffie

Koffie

Drink het koffie koffie

Koffie onder gezien

That's what I plant to do

How I plant it

Let's 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 engraving

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
<table>
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<tr>
<td>1</td>
<td>45413E [CB1] 535658 [Resysta NoWood light]</td>
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<tr>
<td>3</td>
<td>030303 [engraved CB1] 647273 [CB1; light]</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<tr>
<td>4</td>
<td>030303 [engraved CB1] 332D29 [CB1; dark]</td>
<td>-</td>
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<td>7</td>
<td>E7E9DD [white paint] C2A88D [dishwasher CB1; light]</td>
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<td>-</td>
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<td>8</td>
<td>E7E9DD [white paint] 564D3F [dishwasher CB1; dark]</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>9</td>
<td>A8BCAC [white paint] 5F503C [coated CB1; light]</td>
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</table>

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

Main drivers

**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

(1) material selection

(2) product lifetime

(3) end-of-life scenario

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

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

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

CoffeeBased 2
Sugarcane based BioTechPolymer

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

II. Plate welding
(-) no adhesives, no treatment

(+/-) 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

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 & ESA (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

Downloaded again and ready 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
initials: I
student number: 4363809
street & no: --
zipcode & city: --
phone: --
email: --

Your master programme: (only select the options that apply to you):
IDE master(s): [ ] IFD [ ] DII [ ] SFD
2nd non-IDE master:
individual programme: --
give date of approval: --
honours programme:
specialisation / annotation: --

Honours Programme Master
Media
Tech. in Sustainable Design
Entrepreneurship

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 / CIS

** mentor: Marten Bakker
dept. / section: SDE / PAD

2nd mentor: Lisanne Adink - Delile
organisation: CoffeeBased
city: Rotterdam
country: the Netherlands

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**

**APPROVAL PROJECT BRIEF**
To be filled in by the chair of the supervisory team.

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<th>signature</th>
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<tr>
<td>Jan-Carel Diehl</td>
<td>31 - 08 - 2020</td>
<td>jdi_ehl</td>
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**CHECK STUDY PROGRESS**
To be filled in by the iSSC/EBSA (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: 

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<td>02 - 09 - 2020</td>
<td>j.d.bruin, spa</td>
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**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, disapprove 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 an 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?

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IDE TU Delft - EBSA Department /// Graduation project brief & study overview /// 2018-01 v30  
Page 2 of 7
Furniture panels out of CoffeeBased material; used for condiment rack

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
end date 06 - 03 - 2021

INTRODUCTION

Dutch waste incinerators burn 300 million kilo of coffee grounds annually accumulated by the Dutch population. Product manufacturer CoffeeBased 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 production rates (CoffeeBased, 2020).

The company

CoffeeBased manufactures products made from 100% biobased plastics derived from the retrieved coffee grounds (Addink-Dole, 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
image / figure 1: CoffeeBased's sheet material (a) and furniture panel (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 ECT (60 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 (example: 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/orAnnotation, 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 coffee-based 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 100% biobased material in a design and acknowledging the worth of waste will hopefully inspire designers to do and think likewise.

IDE TU Delft - EBSA Department // Graduation project brief & study overview // 2018-01 v30

Initials & Name: Vester 4374  Student number: 4363809
Title of Project: Furniture panels out of CoffeeBased material used for condiment rack
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, delivers 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.

- (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 on a 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 VendaarDGoed, 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 Rotterzwan D1441. And now I have come to learn that the coffee grounds left unused by CoffeeBased go directly to the Rotterzwan 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.


IDE TU Delft - EBSA Department /// Graduation project brief & study overview /// 2018-01 v30
Initials & Name: Vester 4374  Student number: 4363809
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 discredits and deteriorates 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.

**Panel proposal**

Bound by the desires of the end user, processability 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".

**Context resistance**

A BioPh 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. Thus, the proposed panels are selected to be "okay to burn". The proposed panel has a 85% waste content increase as well as a bio-based content increase of 15%, while providing a potential VOC emission reduction of 1%.

**from panel**

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 front**

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.

**to product**

**via material testing**

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Indy Vester  
Sustainable material research: Panel to Product  
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Integrated Product Design

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