ChessMash



Group 24

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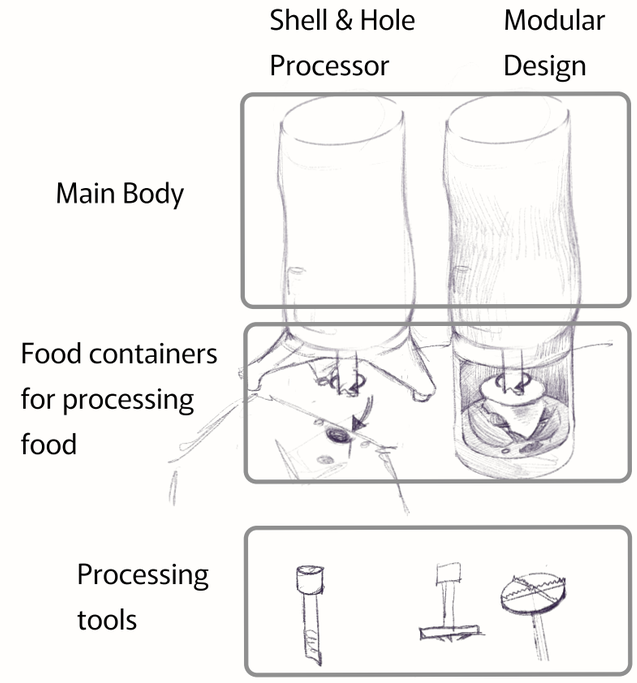
CONCEPT DEVELOPMENT

Selection Rationale

Target group: young cooking beginners struggling with cutting tasks.
Chosen design: Handheld, battery-powered, and electro-mechanical, focusing on innovation and feasibility.

The matrix led us to the Shell & Hole Processor.

Selection Criterion	Multifunctional Chopping Board	Egg Breaker	Automatic Alert Cutting Board	Shell & Hole processor	Conveyor Chopper	Knife Dryer Block	Knife Sharpener & Cleaner
Electronic	✓	✓	✓	✓	✓	✓	✓
Mechanism	✘	✓	✘	✓	✓	✓	✓
Feasibility		✘	✘	✓	?	✓	✘
UIUX				✓	✓	✓	
Innovation				✓	✘	✓	

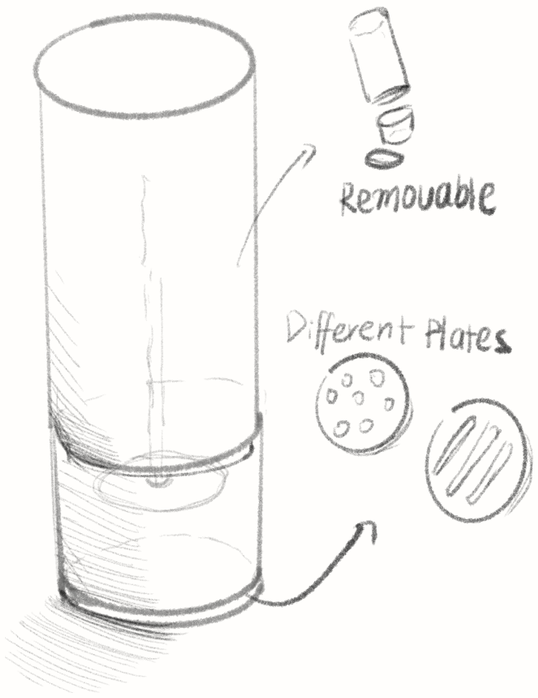


Concept transformation

Stage 1: Refocused on potatoes due to their popularity and ease of preparation. Targeting novice cooks with a potato-smashing tool.

Stage 2: Expanded the tool to a multi-functional smasher for vegetables, fruit jams, noodles, and desserts.

Stage 3: Designed a modular unit for easy cleaning and storage, featuring electronic controls, a round bowl wall for attachments, and various pattern plates for mashing, squeezing, and molding.



To ensure easy cleaning and minimal storage, our product features a modular design with three components:

1. Body: Houses electronic components, includes up and down buttons, a charging port, and is designed for handheld use.

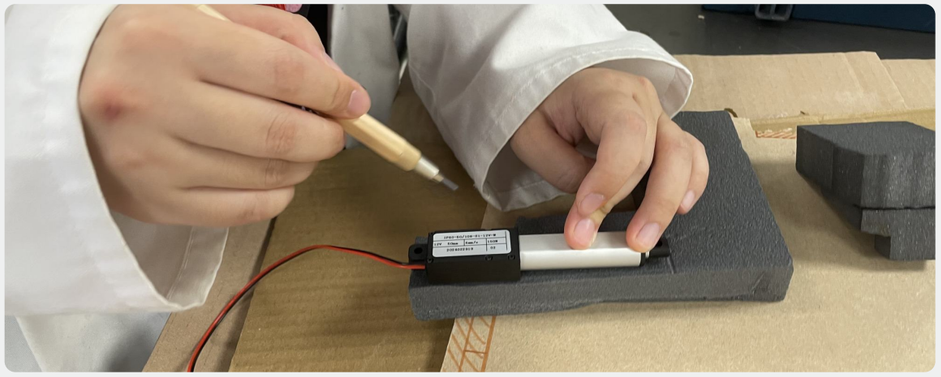
2. Food Container: Connects the main unit to various bottom plates and provides food storage.

3. Bottom Plates:
- Flat with Holes: Varying sizes and shapes for smashing food and making noodles.
- Curved with Holes: For squeezing fruits like lemons.
- Dessert Mold: For making desserts like mooncakes and wagashi.

CONCEPT DEVELOPMENT

Form Design

To design a compact, handheld device, we identified essential electrical components and tested their placement with foam models. From initial sketches, three forms were chosen for foam prototyping. A selection matrix helped finalize the design based on manufacturing feasibility, aesthetics, and user preferences.

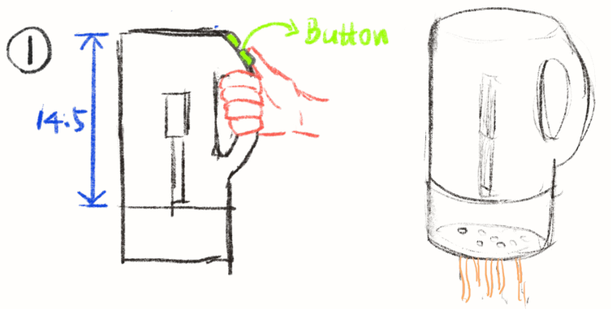


We first used foam to replicate the shape and size of an electronic module.

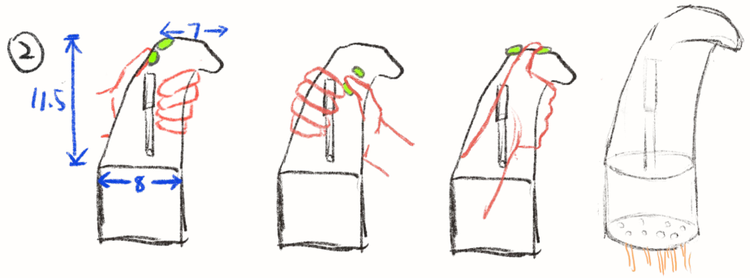




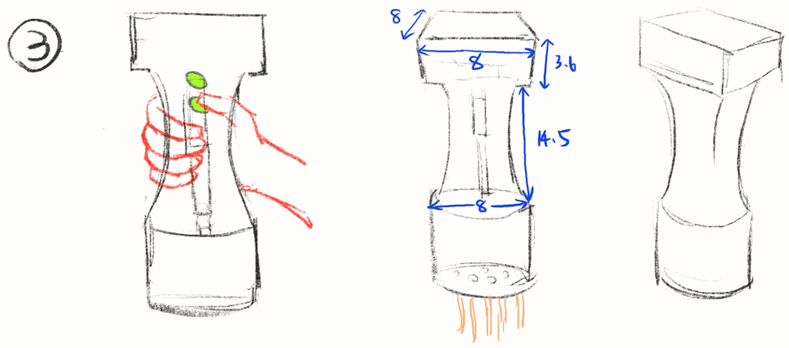
We explored possible placements of the electronic components and adopted configurations that are easy and comfortable to hold, using these as inspiration for the form design.

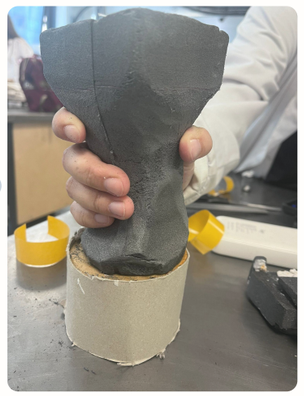






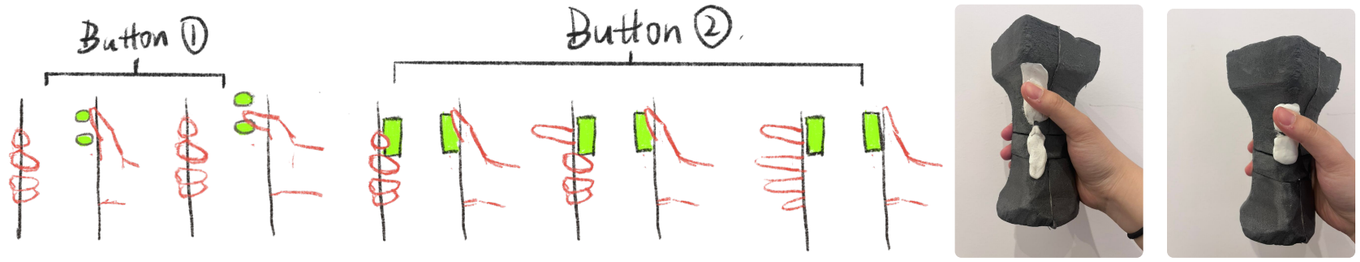





Concept 3 is chosen due to its ease of manufacturing, geometric elegance, and user preferences.

CONCEPT DEVELOPMENT

Control System Button Design

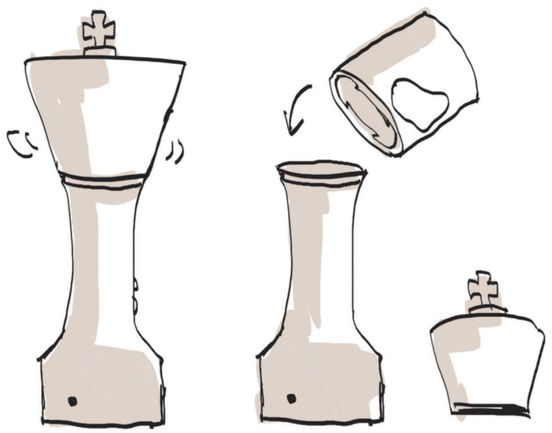


We tested two button control systems:

1. Button Logic 1: Press button A to smash food, release to stop; press button B to retract the push head.
2. Button Logic 2: Press both buttons to smash food; release one to stop, release both to retract.

Despite its innovation and better grip, Button Logic 2 required repeated explanations for users to understand. To ensure ease of use, we chose Button Logic 1 and designed a thinner grip for a tighter hold. We also reduced the button size for easier switching between buttons.

ChessMash — plates storage design and product name creation

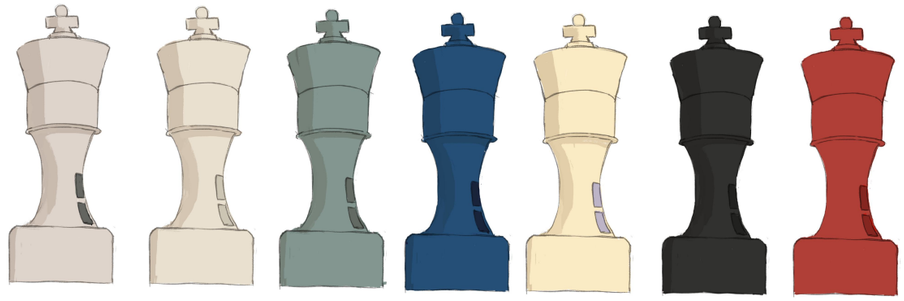


The flat pattern plates are thin and easy to misplace, so we designed a small storage box.

To make the design more engaging, we created the multi-functional smasher in the shape of a chess piece, named ChessMash.

ChessMash is a compact smart kitchen tool aimed at simplifying cooking for beginners with limited kitchen storage space.

Color Selection



We explored several colors and found that people prefer white tones (warm white, grey white) as they match kitchens better and are less likely to become tiresome.

Material

We chose polycarbonate for the transparent, food-contact safe, and dishwasher safe container. For the rest of the product, we opted for recyclable polypropylene (PP) due to its cost-effectiveness and environmental benefits.

Finish

To achieve a high-quality, durable, and damage-resistant finish that always looks clean, we decided to use a matte surface finish.



PP



PC



Benchmarking Analysis of relevant products by Brand

BRANDING CONSIDERATIONS



IDEALISK

Potato press, stainless steel

£9

Brand summary

- Globally recognized for its affordability
- A familiar choice for students
- Available both in-store and online
- Emphasizes environmentally friendly materials.



Helix Yellow Citrus Juicer

£ 19.49

Brand summary

- Well -shaped and high quality
- No electronic products
- Not well-known among many overseas students
- Prices are higher compared to similar brands



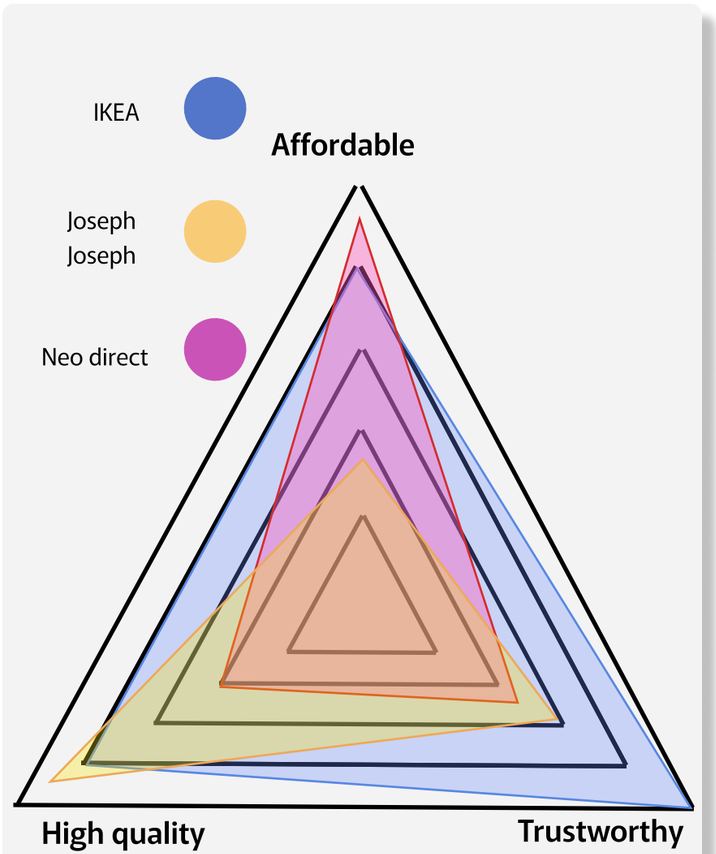
Neo 4 in 1 Stainless Steel Digital Soup Maker

£59.99

Brand summary

- Price are relatively low.
- Has mixed reviews regarding product quality
- No physical stores.

Brand selection



IKEA aligns most closely with our brand concept.

IMPLEMENTATION OF BRANDING ON PHYSICAL PRODUCT

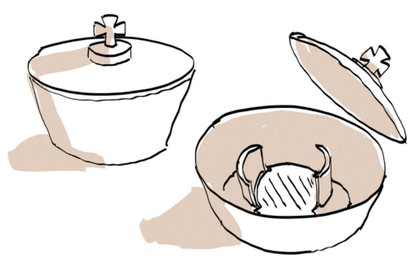
ChessMash with IKEA's conceptS

Three keywords for our brand are:
Affordable
High quality
Trustworthy



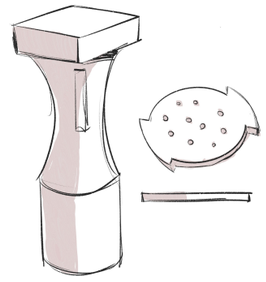
Time saving

- Materials are polypropylene (PP) and polycarbonate (PC)
- Dishwasher safe
- lightweight nature and easy to handle



Time saving

Top box for storing bottom plates, avoiding misplaced kitchen utensils.



Space & money Saving

- Slim shape
- Users can customize product functions by changing bottom plates

Products in IKEA's room for students



Space saving Wardrobe combination: drawers and clothing racks



Simple color schemes like black and white.

PHYSICAL PROTOTYPING

Main Body



- Upper Cubic Part: The initial prototype underestimated the space for electronic components, leading to an upgraded design with increased height.
- Grip Area: Height was increased for user comfort, and the diameter was reduced for better ergonomics based on user feedback.
- Button: A smaller, square-shaped button replaced the long strip press button to make switching easier for users.

Bottom Plates

Different plates with various hole sizes are being printed to test their effectiveness on our target foods, including potatoes, noodle dough, mooncakes, lemons, and fruits.

Initial printed plates



Lemon squeezing test



Dough extrusion test





Mash Plate



Noodle Plate



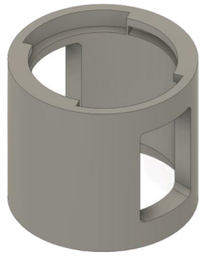
Lemon Plate



Mooncake Plate

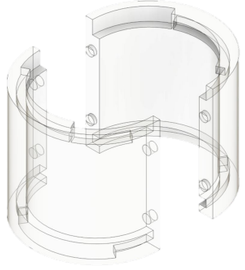
Food Container

Initially, we planned a container with a solid PP wall and two transparent PC parts for visibility. However, this complex design was unsuitable for injection molding, making it challenging and costly.



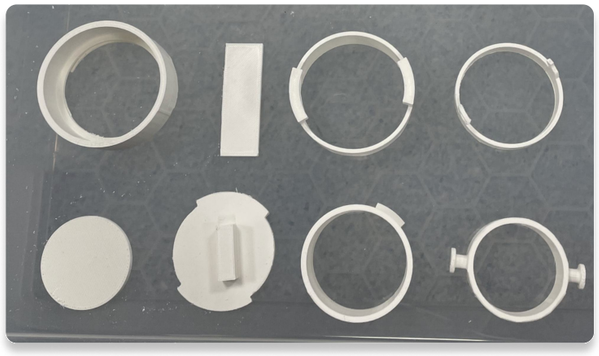
Material: PP+PC
Partially transparent

Instead, we've opted for a fully transparent PC container. This new design is divided into two parts assembled using a boss structure, facilitating injection molding while maintaining visibility and reducing costs.



Material: PC
Full Transparency

Connection



Initial 3D printing for testing



Latch 1



Latch 2

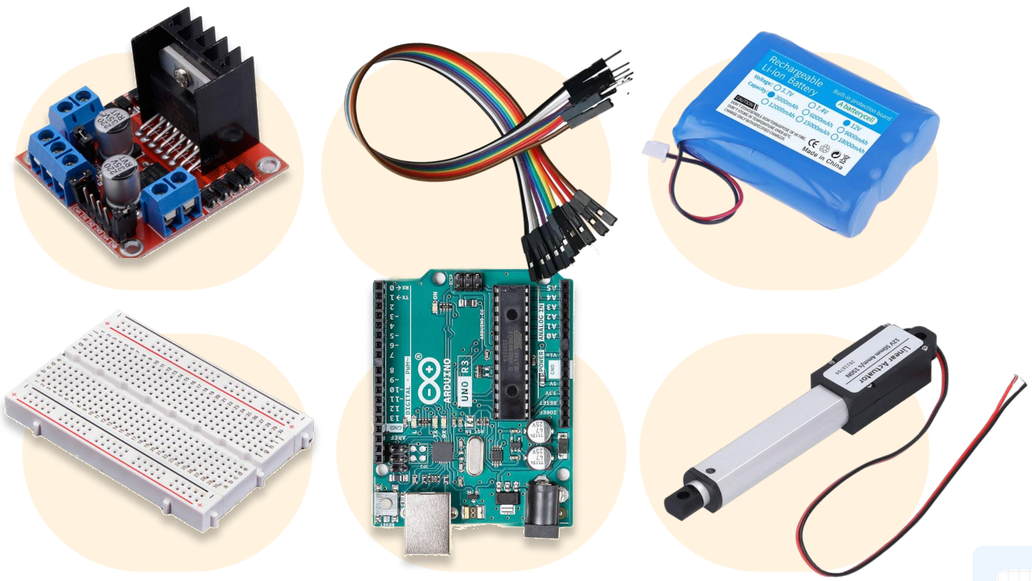


Bayonet mount

For connecting the container and body, we tested two methods: the bayonet mount and the hook. 3D-printed prototypes showed the bayonet mount was more convenient and stable.
For connecting the bottom plates and container, we compared the bayonet mount and latch. Prototyping revealed the latch required more parts and complex installation, while the bayonet mount was easier to install and provided excellent sealing.

ELECTRICAL PROTOTYPING

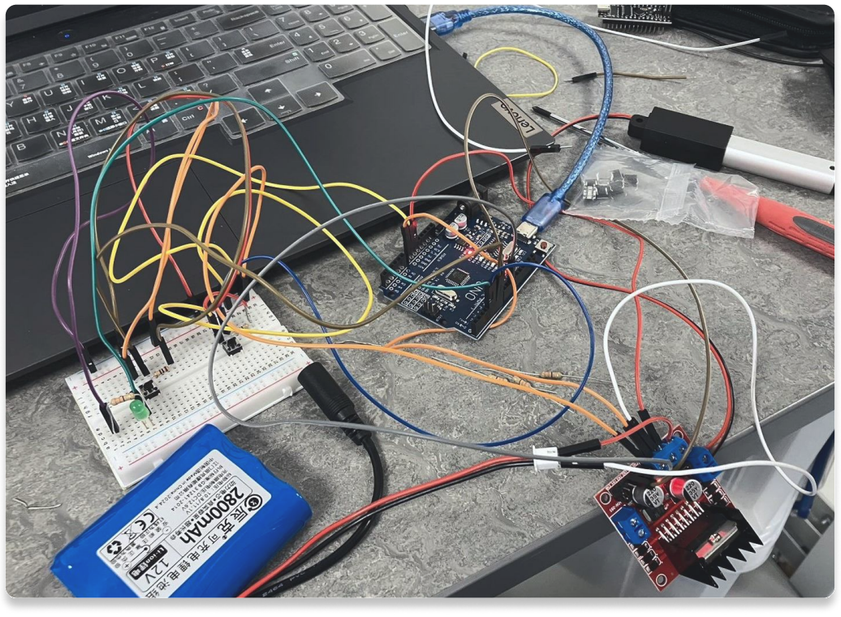
Prototyping Components



Based on our product's nature, our circuit design must meet the following criteria:

- **Compactness:** Minimize the top section size to enhance stability and improve the user's grip experience.
- **Cost-effectiveness:** Ensure the electronics are affordable for young cooking beginners, emphasizing simplicity and low cost.
- **Sufficient Power:** Provide the actuator with enough power to effectively mash ingredients.

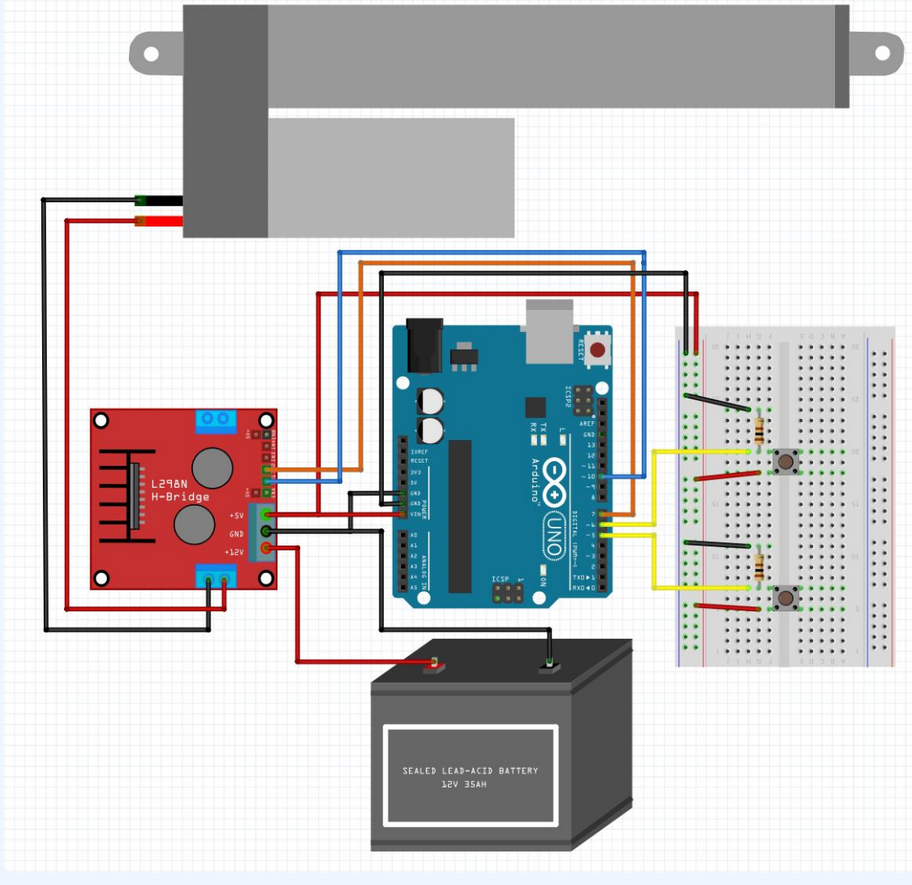
Initial Prototype

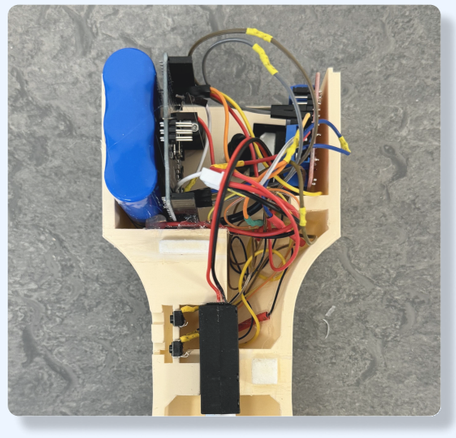


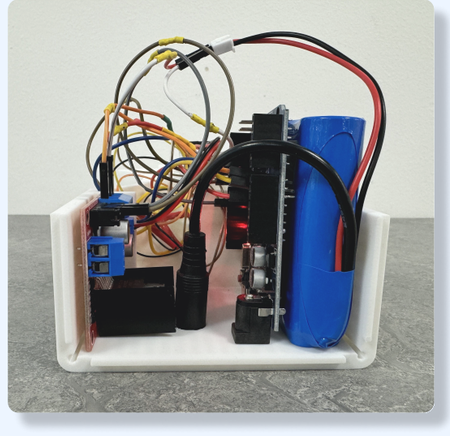
A breadboard and jumper wires were used for the initial circuit setup. These simple and flexible components shortened the testing process and improved efficiency.

Final Prototype

To save space and improve reliability, wire lengths were shortened and soldered, eliminating the need for a breadboard, and the final circuit diagram was created.







POWER AND LOAD CALCULATIONS

Power Calculation:

All power-consuming components: P = VI

Arduino（5V-92.63mA） P=0.463W

Actuator（12V-2A） P=24W

L298N（12V-36mA） P=0.432W

Button（5V-50mA） P=0.25W

Battery Duration Calculation:

Total average power consumption:

P total = 0.463W+24W+0.432W+0.25W = 25.145W

The battery is 12V with a 2800mAh capacity:

I average = 25.145W/12V = 2.0954A

Battery Life = 2.8Ah/2.0954A = 1.336 hours

Capacity	Dimension	Mass	Max Power
12V 2800mAh	68x55x19 mm	170g	<70W
12V 5600mAh	66x55x40 mm	320g	<90W
12V 8400mAh	66x59x55 mm	470g	<90W
12V 11200mAh	77x66x55 mm	620g	<90W

Finite Element Analysis:

Material Strength:

- UTS of PP: 24.96 MPa
- Observed maximum stress: 2.5203 MPa (no risk of yielding)

Design Reliability:

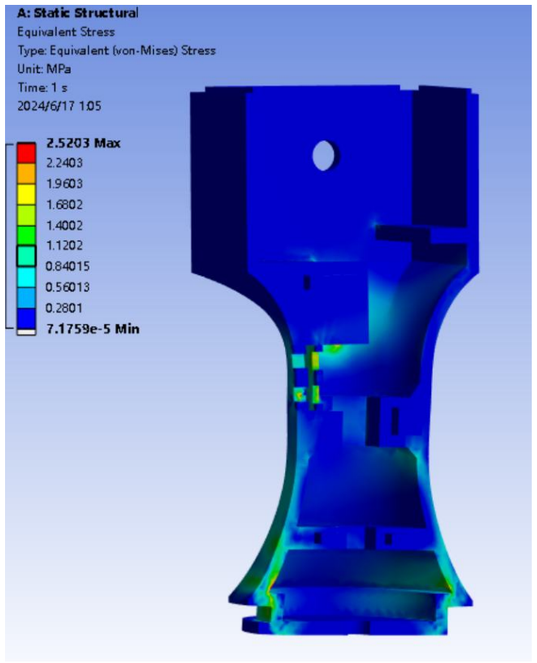
- Safety factor: 15 (ensuring reliability and stiffness)

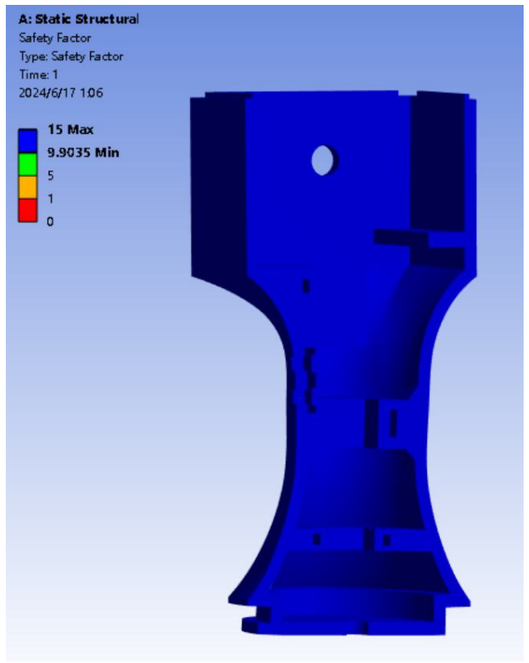
Deformation:

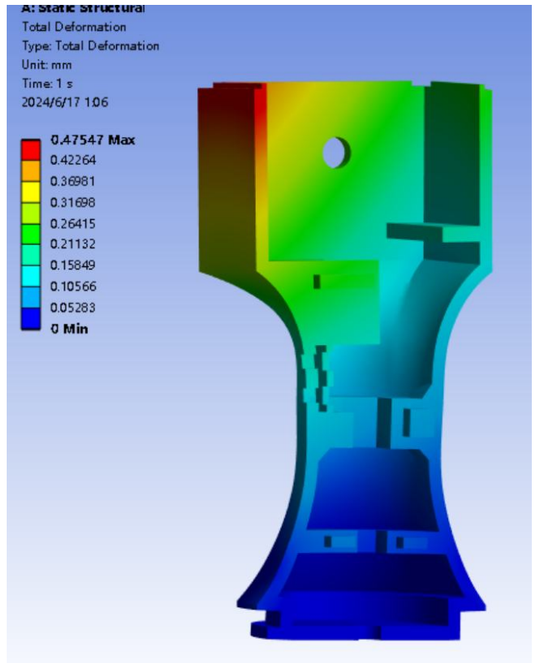
- Maximum deformation: 0.47547 mm (within design limits)

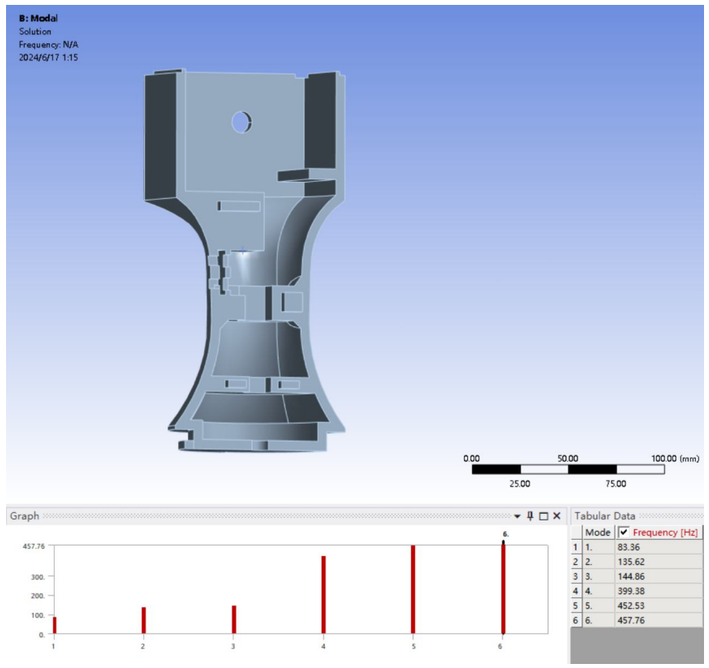
Frequency:

- Actuator operational frequency: 40 Hz
- Lowest natural frequency: 83.35 Hz (preventing resonance)

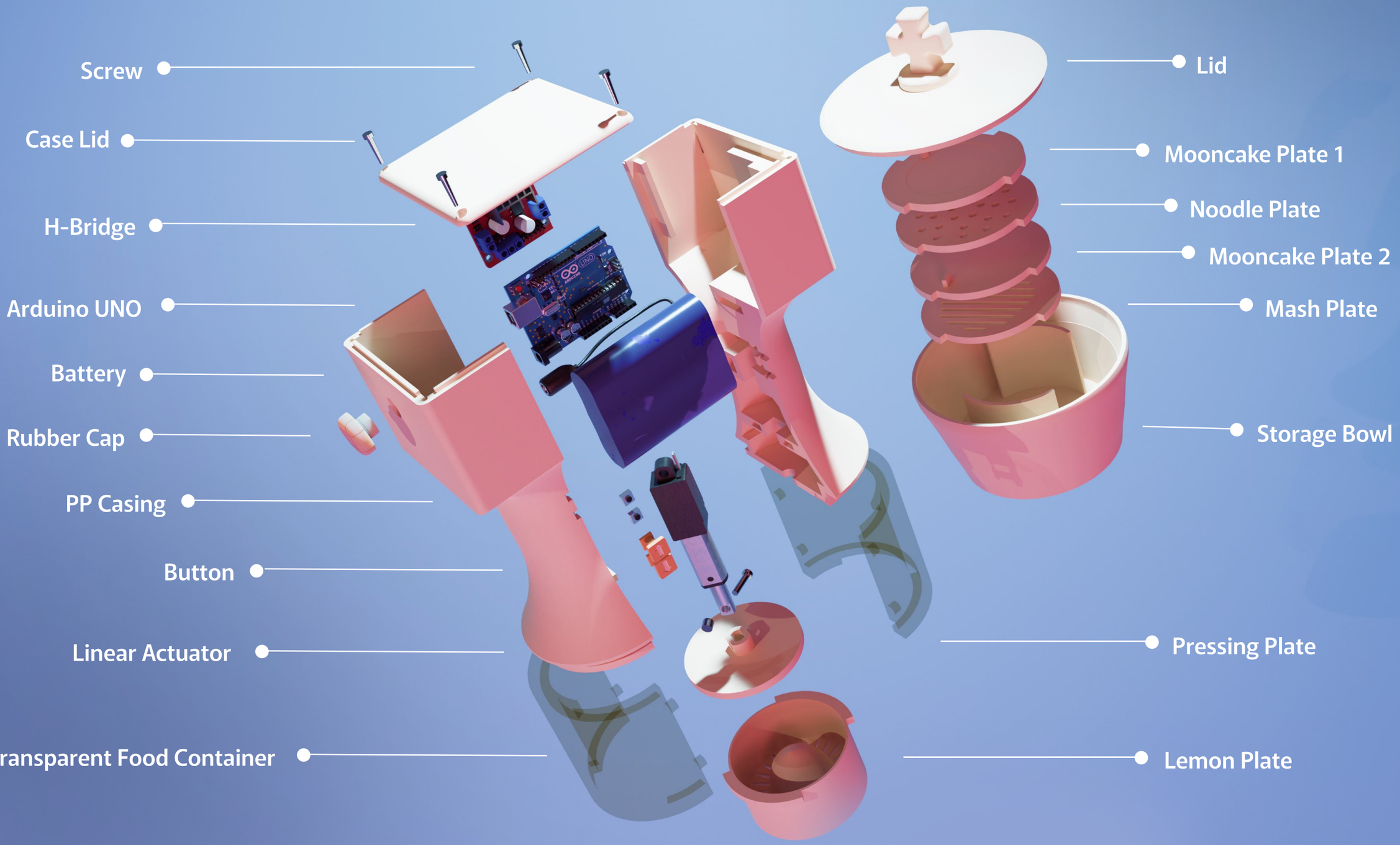








DETAILED DESIGN (DFMA)



DETAILED DESIGN (DFMA)

Charging Port Hole

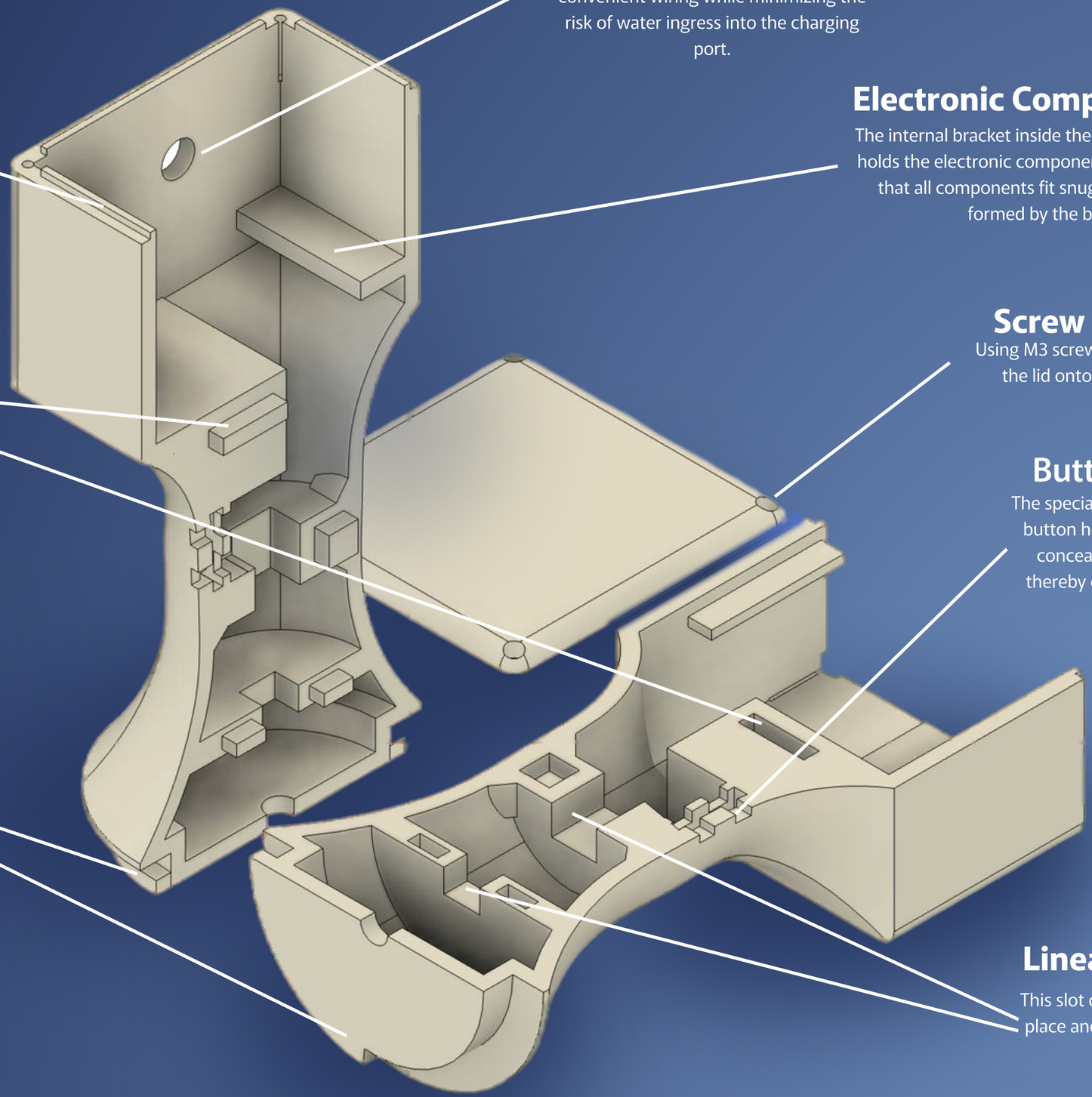
The charging port hole is placed on the upper half of the body casing, ensuring convenient wiring while minimizing the risk of water ingress into the charging port.

Boss

The boss on the top of the casing can interlock with the recess on the cover, facilitating alignment during assembly.

Electronic Component Bracket

The internal bracket inside the body casing securely holds the electronic components in place, ensuring that all components fit snugly within the gaps formed by the bracket.



Slot

The multiple bosses and slots on the body casing serve to securely fasten the enclosure during assembly. The bosses are designed with larger volumes to enhance the stability and strength of the case.

Screw Hole

Using M3 screws securely fastens the lid onto the body case.

Button Hole

The specially designed structure of the button hole allows the button to be concealed within the body case, thereby enhancing the overall seal.

Bayonet Mount

The bayonet mount at the bottom of the body case allows for easy assembly and disassembly of the body and food container, facilitating user-friendly use and cleaning.

Linear Actuator Slot

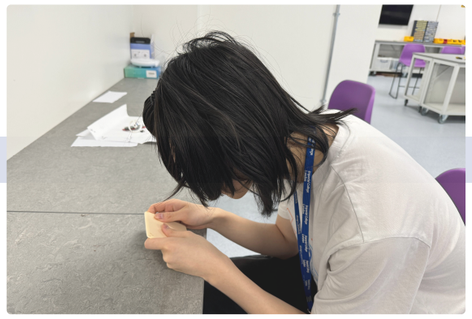
This slot can hold the linear actuator in place and withstand the counterforce generated by it.

PRODUCT ASSEMBLY PROCESS

Preparation

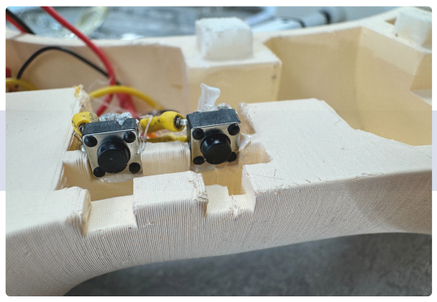


Finishing 10 min

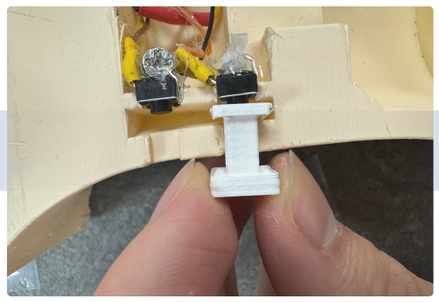


Checking 2 min

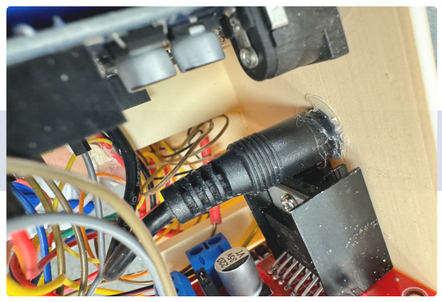
Electronics Assembly



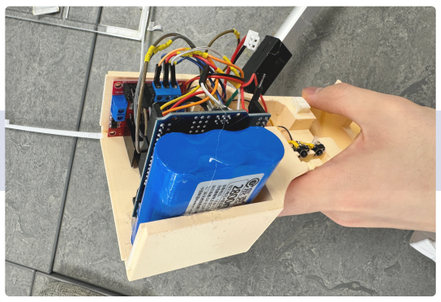
Button 2 min



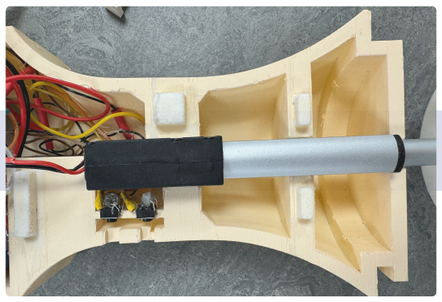
Button Cap 1 min



Charging Port 1 min

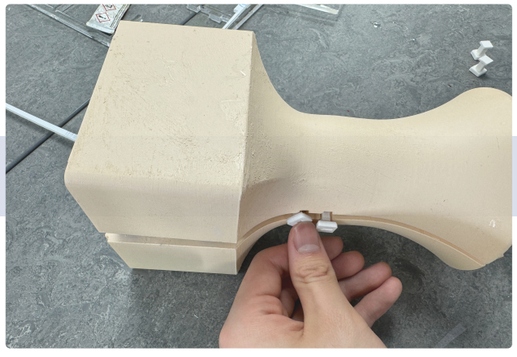


Circuit 4 min

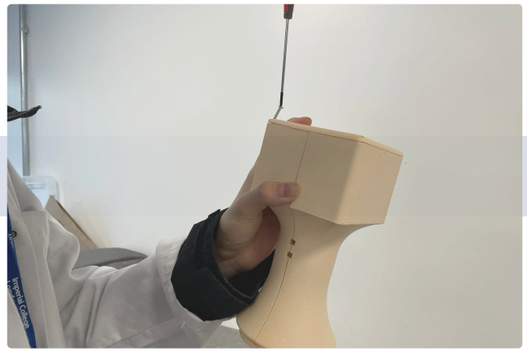


Linear Actuator 2 min

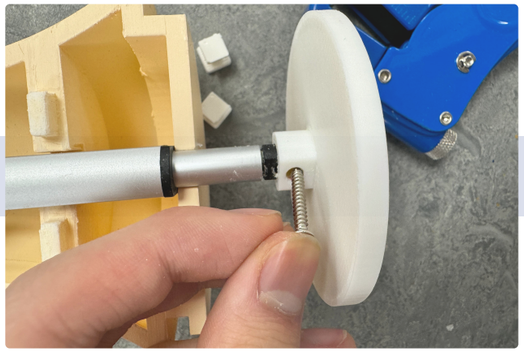
Final Assembly



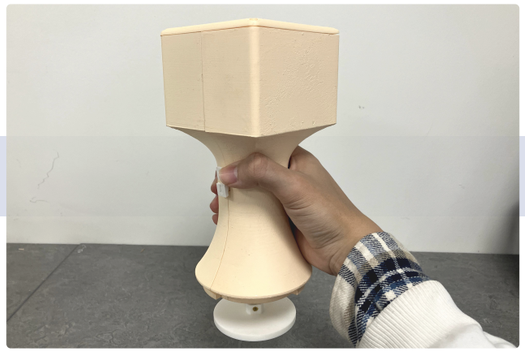
Body Case 1 min



Case Lid 2 min



Pressing Plate 3 min



Finished

Total Assembly Time: 28 min

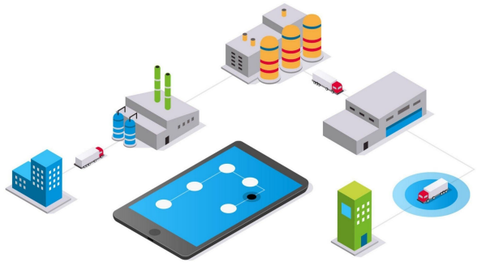
PRODUCT COMPLIANCE

To ensure that ChessMash, our multifunctional food smasher, can be sold in the UK and EU markets, it must adhere to specific laws, directives, and standards. These regulations ensure product safety, prevent foreseeable misuse, and maintain environmental responsibility.

CE Marking: Required for products sold within the European Economic Area (EEA).
UKCA Marking: Required for products sold within the UK.

General Product Safety

The product should comply with The General Product Safety Regulations 2005 and Consumer Protection from Unfair Trading Regulations 2008, ensuring safety, accurate labeling, and traceability.



Traceability





Electronics

The product should adhere to RoHS Directive (2011/65/EU), REACH regulations, WEEE Regulations, and Battery and Accumulator Regulations 2008, ensuring safe chemical use, proper labeling, recycling, and electromagnetic compatibility.





Food Safety

The product should meet Regulation (EC) No 1935/2004 and Commission Regulation (EU) No 10/2011 standards, ensuring safe materials in food contact, and follow GMP Regulation (EC) No 2023/2006 for high manufacturing standards.



Compliance Reflections in ChessMash

- Battery Safety
- Signal Safety
- Packaging and Proper Labeling
- Sustainability
- Child Safety
- Food-Contact Safety & Dishwasher Safety

Packaging

The product should comply with Directive 94/62/EC, ensuring environmentally friendly packaging with a recycling rate of 25%-45% and proper disposal labeling.



Other Regulations

Fire safety regulations ensure all materials in ChessMash, especially foam filling, pass ignitability tests. The use of lithium batteries is carefully evaluated to minimize health risks, particularly to children and pets.

PRODUCT COMPLIANCE

After gaining sufficient compliance information, we assumed a basic process for compliance testing and created our own product's conformity declaration.

Process of Checking Compliance:

1. **Identify Applicable Directives and Standards**: Determine the relevant directives and harmonised standards that apply to ChessMash.

2. **Review Product-Specific Requirements**: Ensure that ChessMash meets all specific compliance criteria for safety, electronics, and food contact materials.

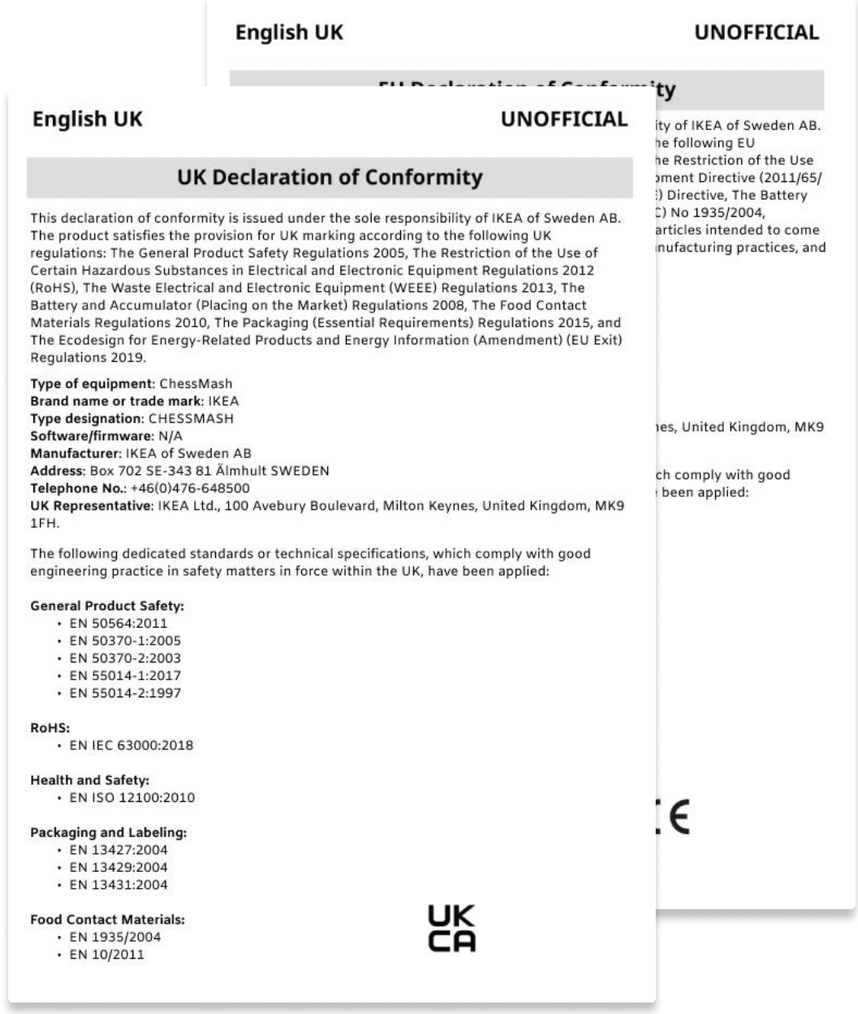
3. **Determine Need for Independent Assessment**: Check if an independent conformity assessment by a Notified Body is required.

4. **Conduct Comprehensive Testing**: Test ChessMash for safety, electromagnetic compatibility, and food safety to ensure it meets all standards.

5. **Prepare Technical Documentation**: Compile and maintain all necessary technical documentation for ChessMash.

6. **Marking and Declaration of Conformity**: Affix the CE and UKCA markings to ChessMash and issue the Declaration of Conformity to certify compliance.

Declaration of Conformity



English UK UNOFFICIAL

UK Declaration of Conformity

This declaration of conformity is issued under the sole responsibility of IKEA of Sweden AB. The product satisfies the provision for UK marking according to the following UK regulations: The General Product Safety Regulations 2005, The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (RoHS), The Waste Electrical and Electronic Equipment (WEEE) Regulations 2013, The Battery and Accumulator (Placing on the Market) Regulations 2008, The Food Contact Materials Regulations 2010, The Packaging (Essential Requirements) Regulations 2015, and The Ecodesign for Energy-Related Products and Energy Information (Amendment) (EU Exit) Regulations 2019.

Type of equipment: ChessMash
Brand name or trade mark: IKEA
Type designation: CHESSMASH
Software/firmware: N/A
Manufacturer: IKEA of Sweden AB
Address: Box 702 SE-343 81 Älmhult SWEDEN
Telephone No.: +46(0)476-648500
UK Representative: IKEA Ltd., 100 Avebury Boulevard, Milton Keynes, United Kingdom, MK9 1FH.

The following dedicated standards or technical specifications, which comply with good engineering practice in safety matters in force within the UK, have been applied:

General Product Safety:
- EN 50564:2011
- EN 50370-1:2005
- EN 50370-2:2003
- EN 55014-1:2017
- EN 55014-2:1997

RoHS:
- EN IEC 63000:2018

Health and Safety:
- EN ISO 12100:2010

Packaging and Labeling:
- EN 13427:2004
- EN 13429:2004
- EN 13431:2004

Food Contact Materials:
- EN 1935/2004
- EN 10/2011

UK CA

For UKCA and CE compliance, the product must include documentation that provides the manufacturer's name and address, details about the product, and information about the conformity assessment body.



UK DECLARATION OF CONFORMITY

EU DECLARATION OF CONFORMITY

SAFETY GUIDE

Important Safety Instructions

Caution

Product Labeling

Packaging Compliance

Electrical Safety

Fire Hazard Prevention

CHESSMASH

Multi-Foodcrush

In the user guide, we have reformatted the Declaration of Conformity to fit our trifold leaflet. The content has been made concise and simple, ensuring it is easy for customers to read, understand, and check online.

LABELING



Product Labeling

UKCA & CE Mark	Indicates that the product conforms to UK and EU standards, respectively.
WEEE Mark	Signifies that the product should not be discarded with general waste but must be taken to separate collection facilities for recovery and recycling.
Product Name	Displays the name of the product.
PP Recycling & Other Plastic Recycling Mark	Indicates that the product is made from recyclable materials, specifically polypropylene (PP) and polycarbonate (PC).
Company	Shows the name of the company and the location of manufacture.

Package Labeling

Indicates that the product is safe for food contact and can be safely cleaned in a dishwasher.	**Food Contact Safe & Dishwasher Safe Mark**
Indicates that the product conforms to UK and EU standards, respectively.	**UKCA and CE Mark**
Signifies that the product should not be discarded with general waste but must be taken to separate collection facilities for recovery and recycling.	**WEEE Mark**
Indicates that all forest-based materials are verified as 100% recycled.	**FSC Mark**
Shows that the packaging is recyclable and meets packaging directives requirements, although it may not be accepted in certain recycling centers.	**Mobius Loop**
Indicates that the product cannot be used by children under 3 years due to potential choking hazards.	**Age Warning Symbol**
Shows that the product is manufactured by IKEA.	**IKEA Logo**



USER GUIDE

SAFETY GUIDE

Important Safety Instructions

1. Read Instructions: Please read all safety instructions thoroughly before using your IKEA Chessmash food crushing machine.
2. Supervision Required: This machine should not be operated by children or persons with reduced physical, sensory, or mental capabilities unless they are supervised by a responsible adult.
5. Avoid Overloading: Do not exceed the recommended amount of food to be crushed at one time to avoid damaging the machine.
6. Hot Surfaces Warning: Some parts of the machine may become hot during use. Exercise caution to avoid burns.
7. No Metal Objects: Do not insert metal objects into the machine to prevent damage and avoid injury.
8. Avoid Contact with Moving Parts: Keep hands and utensils away from the crushing mechanism during operation to prevent injury.
9. Proper Cord Handling: Ensure the power cord is kept away from hot surfaces and is not pinched or tangled.
10. Unplug When Idle: Always unplug the machine when it is not in use, and before cleaning or performing maintenance.

Caution

1. Avoid Heavy Loads: Do not place heavy objects on top of the machine as it may cause damage.
2. Keep Dry: The machine should be kept dry at all times and should not be submerged in water or other liquids.

Product Labeling

1. Model Name: IKEA Chessmash food crusher
2. Input Voltage: Rechargeable battery(12V)
3. Compliance: CE, UKCA

Packaging Compliance

We ensure that all relevant safety and environmental standards are adhered to during our packaging process, in line with IKEA's commitment to sustainability.

Electrical Safety

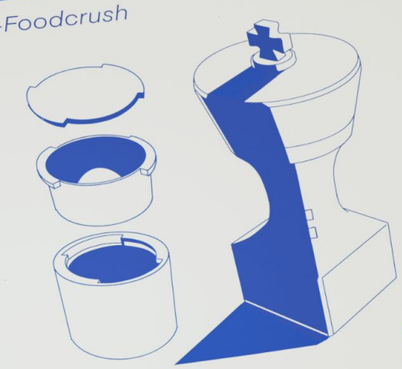
1. Proper Grounding: Ensure the machine is properly grounded to avoid electrical hazards.
2. Check for Damage: Do not use the machine if the power cord or plug is damaged. Contact IKEA customer service for repairs or replacement.

Fire Hazard Prevention

- No Covering During Use: Avoid covering the machine while in operation to prevent overheating and fire risk.

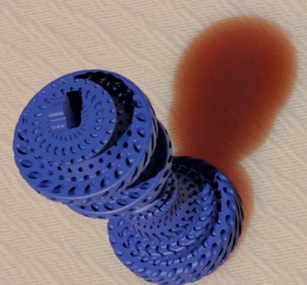
CHESSMASH

Multi-Foodcrush

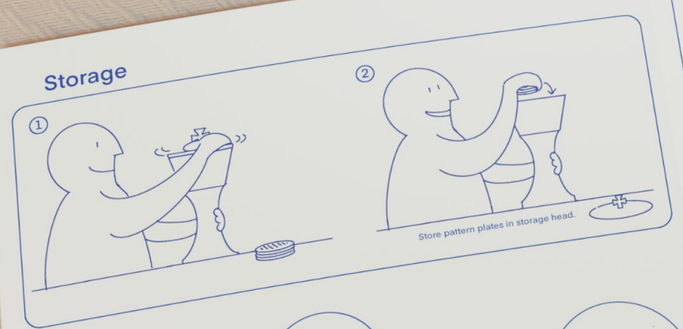


IKEA





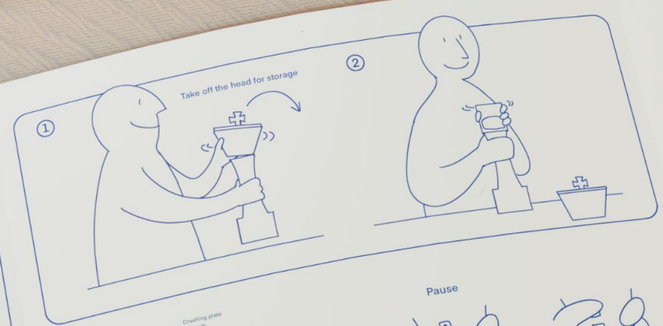
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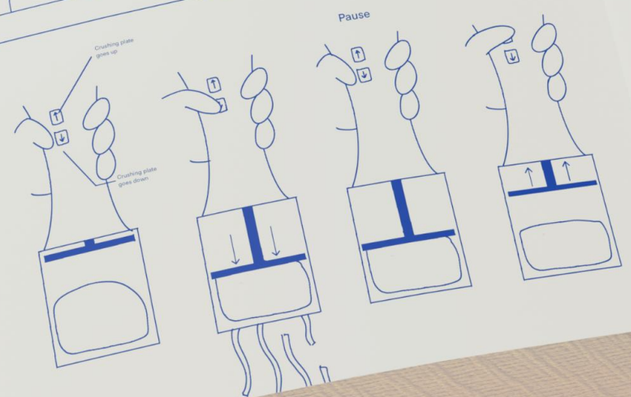


Cooking



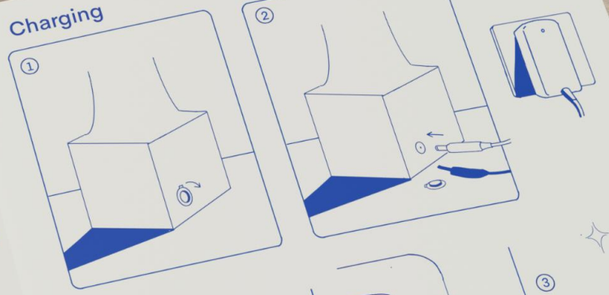
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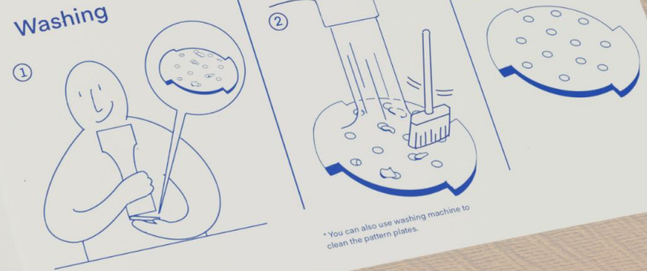


2

Charging



Washing



* You can also use washing machine to clean the pattern plates.

3

PRODUCT PACKAGING DESIGN





IKEA is eliminating plastic from its consumer packaging. So the packaging is a slide-out cardcoard box. We primarily uses black cardboard to support and secure internal components within the package.

Internal design



LAYER 1

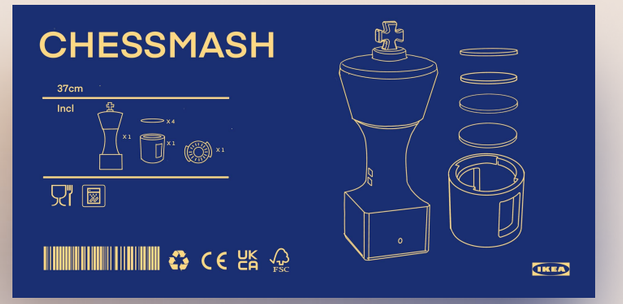
- Recipe
- User guide

LAYER 2

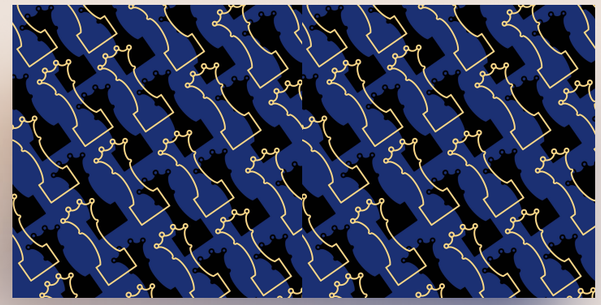
- Product
- Bottom plate
- Charging cable

Graphic design

Front



Left/right



Back



Upper part



CHESSMASH

X1

X1

X1

CHESSMASH

CHESSMASH

37cm

Incl

X4

X1

X1

X1

IKEA

CE UK CA

COOKING RECIPE

SAFETY GUIDE

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Fire Hazard Prevention

CHESSMASH

Multi-Foodcrush

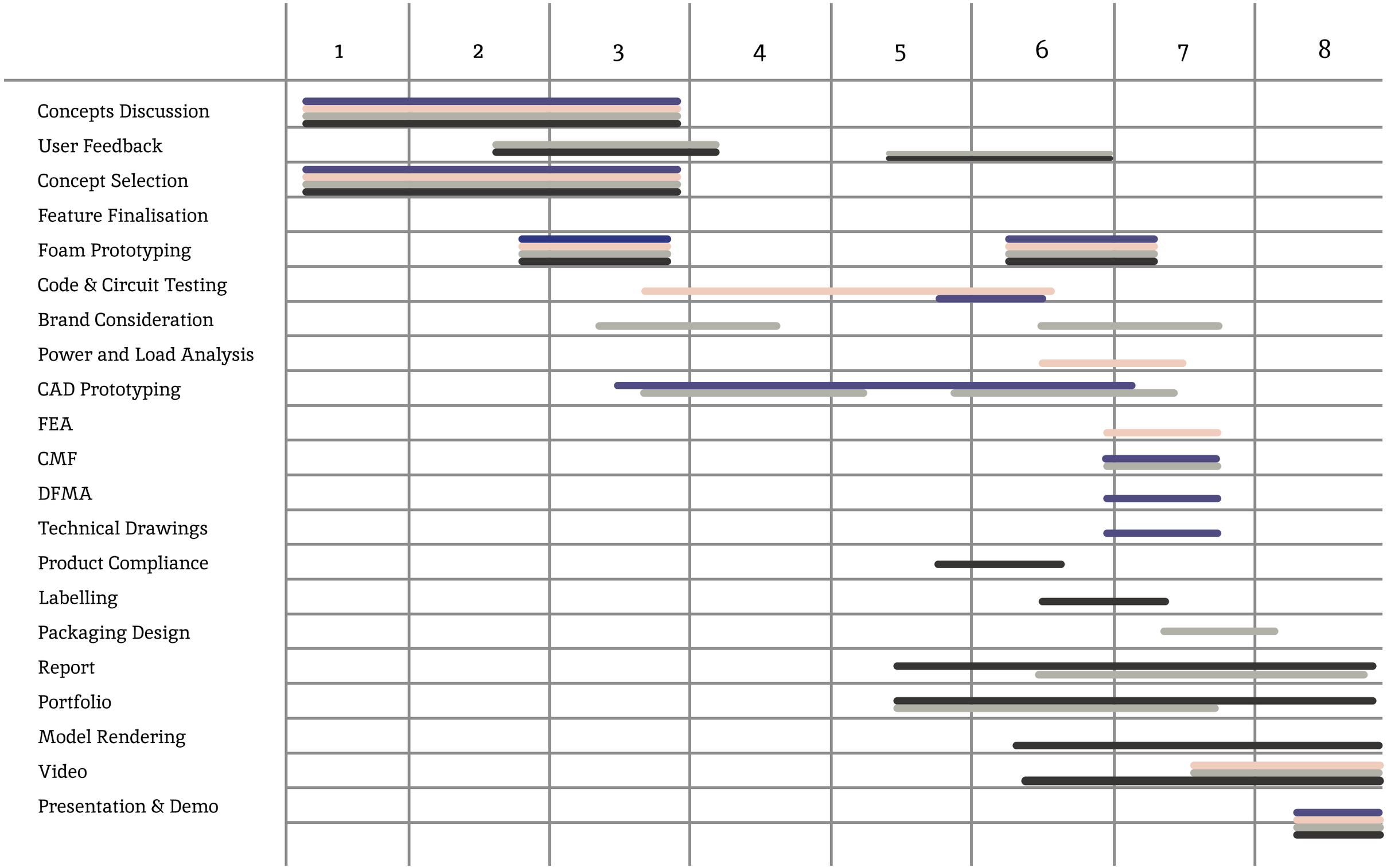
IKEA


ChessMash

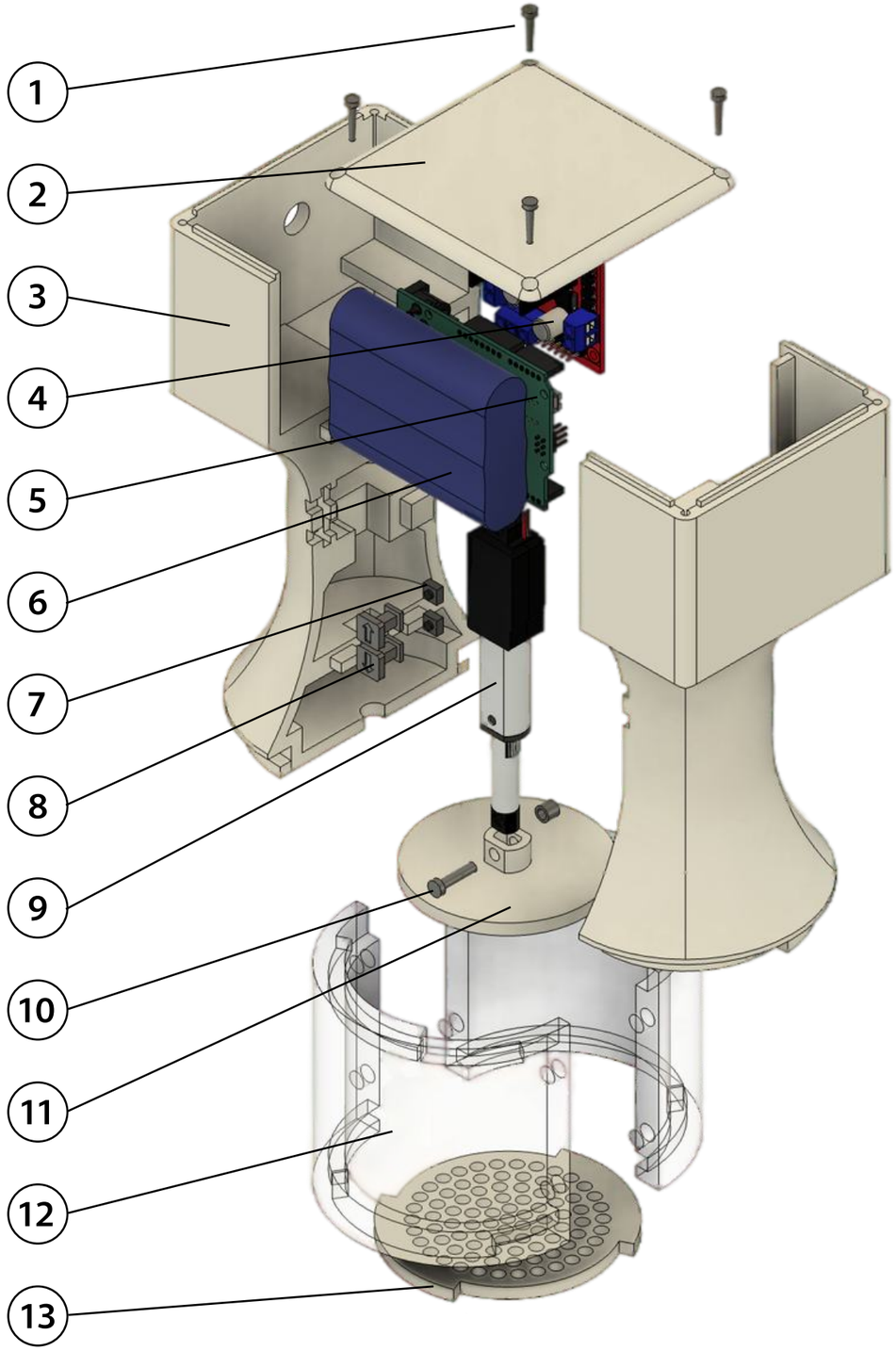
ChessMash

PROJECT PLAN

Xiangsong Zhang | Warren Tie | Miaoyan Tang | Qinxuan Li

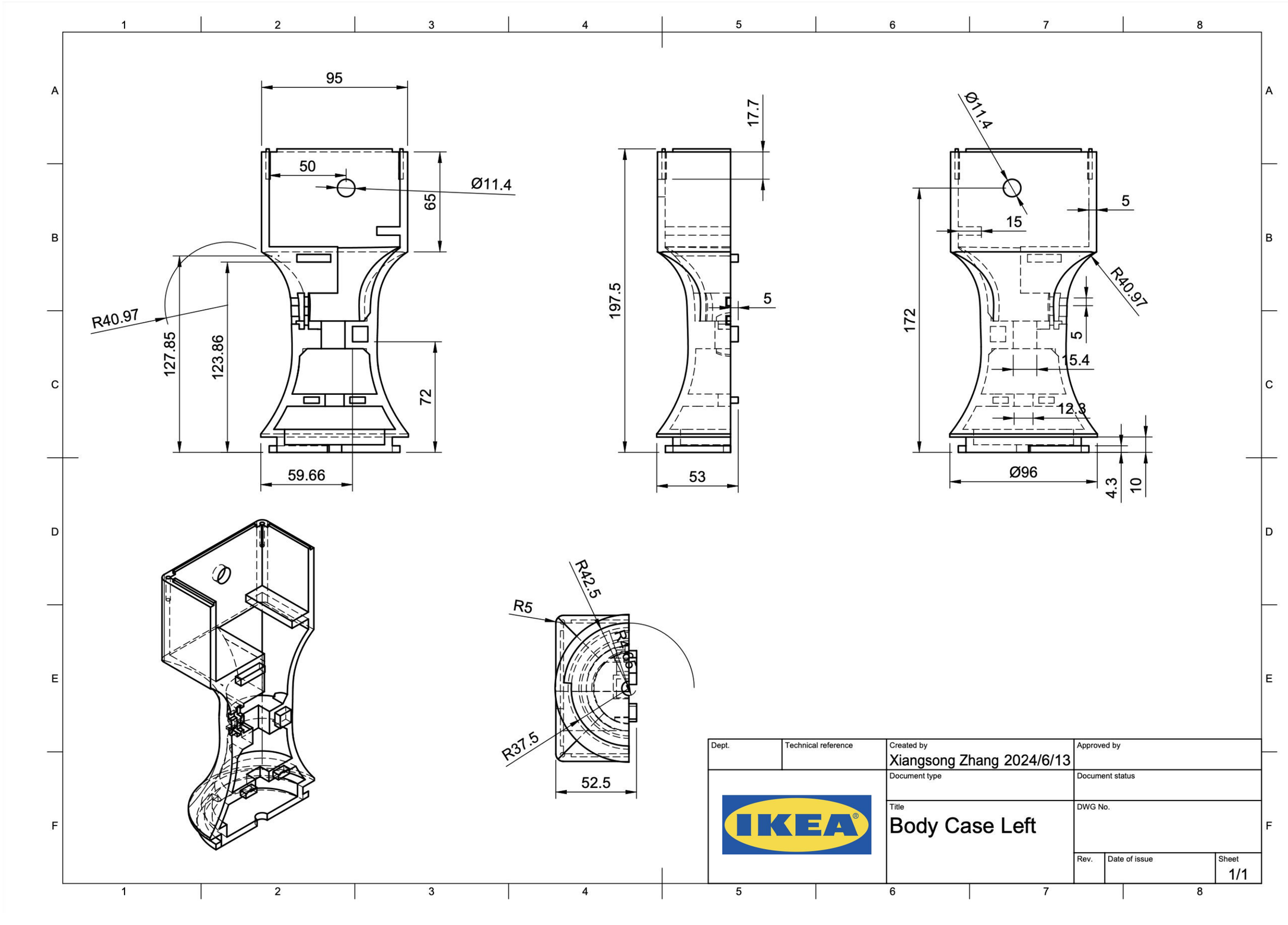


PRODUCT DATA PACKAGE



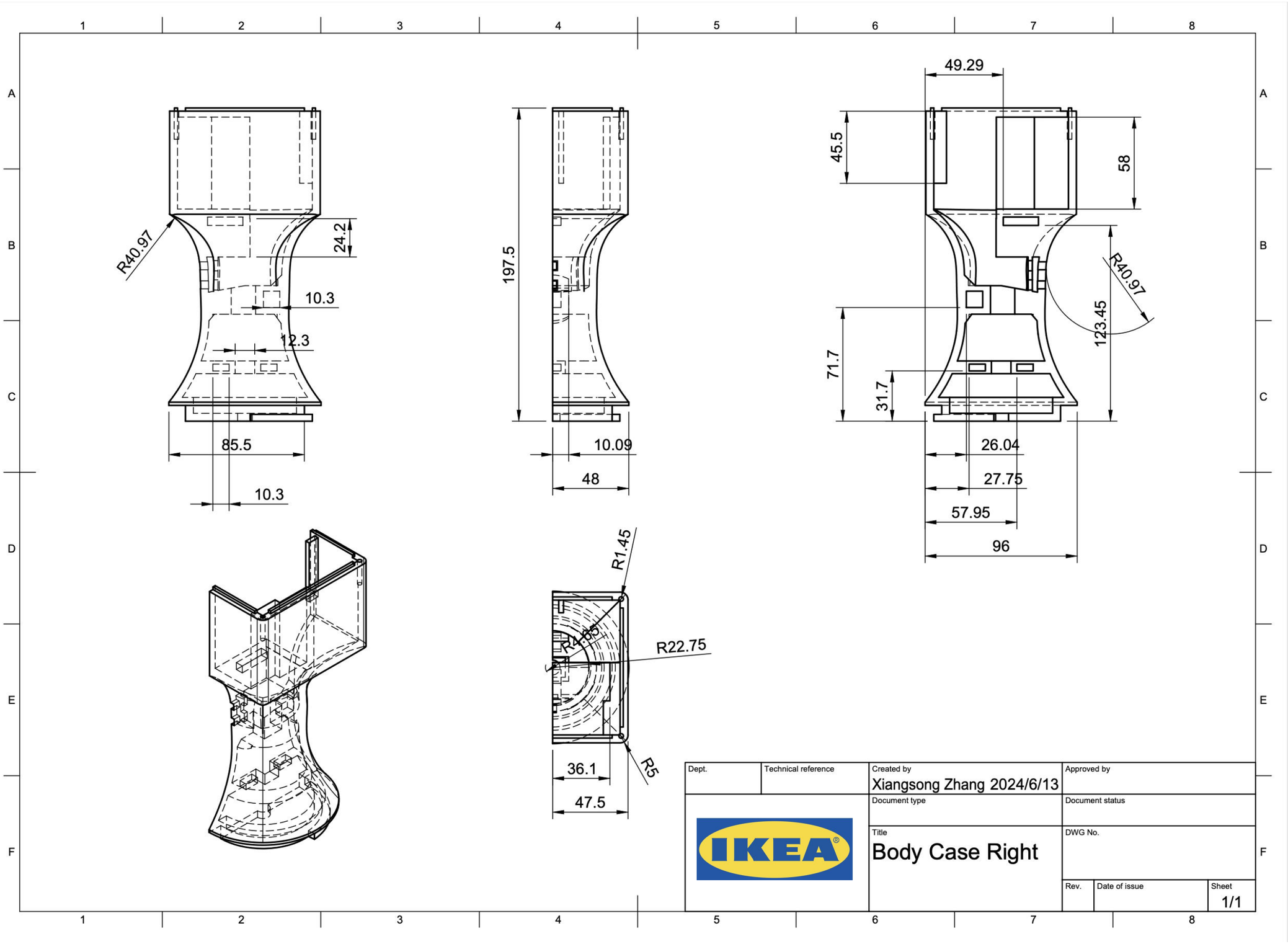
No	Component	Purpose	Quantity	Total Price (£)
1	Screw	keep the case fixed	4	0.34
2	Case Lid	cover all components from top	1	0.53
3	Body Case	hold the components inside	2	2.57
4	H-bridge	control the motor in linear actuator	1	1.5
5	Arduino UNO	control electrical components	1	9.4
6	Power Bank	provide power for electrical components	1	5.3
7	Button	control the movement of the linear actuator	2	0.2
8	Button Cap	enhance the button's operability	2	0.03
9	Linear Actuator	press the food that need to be processed	1	22
10	Screw	keep the pressing plate fixed	1	0.08
11	Pressing Plate	press the food uniformly	1	0.57
12	Food container	connect the body and the bottom plate	1	2.67
13	Bottom Plate	provide the product different functions	5	1.66
				46.85

PRODUCT DATA PACKAGE

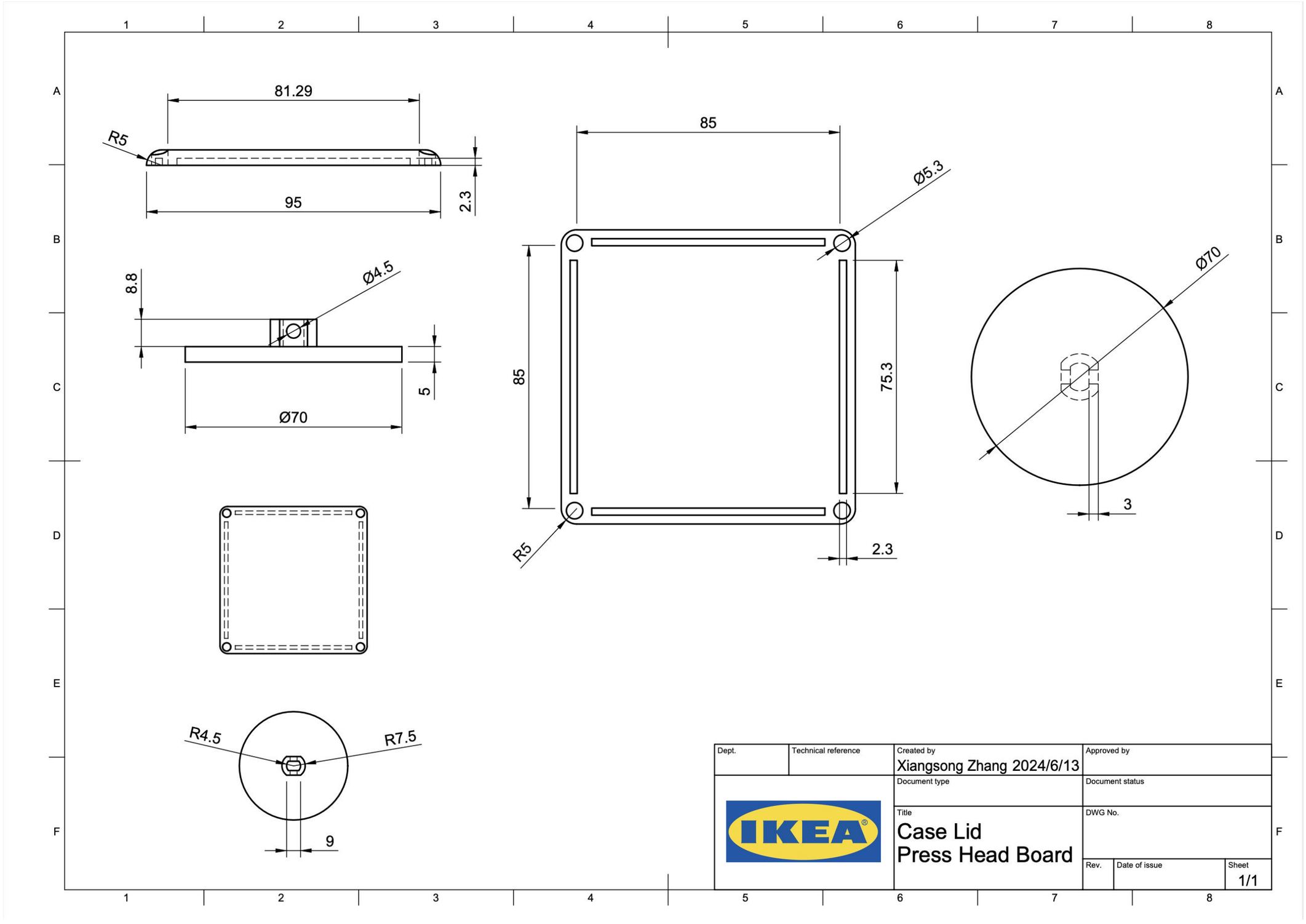


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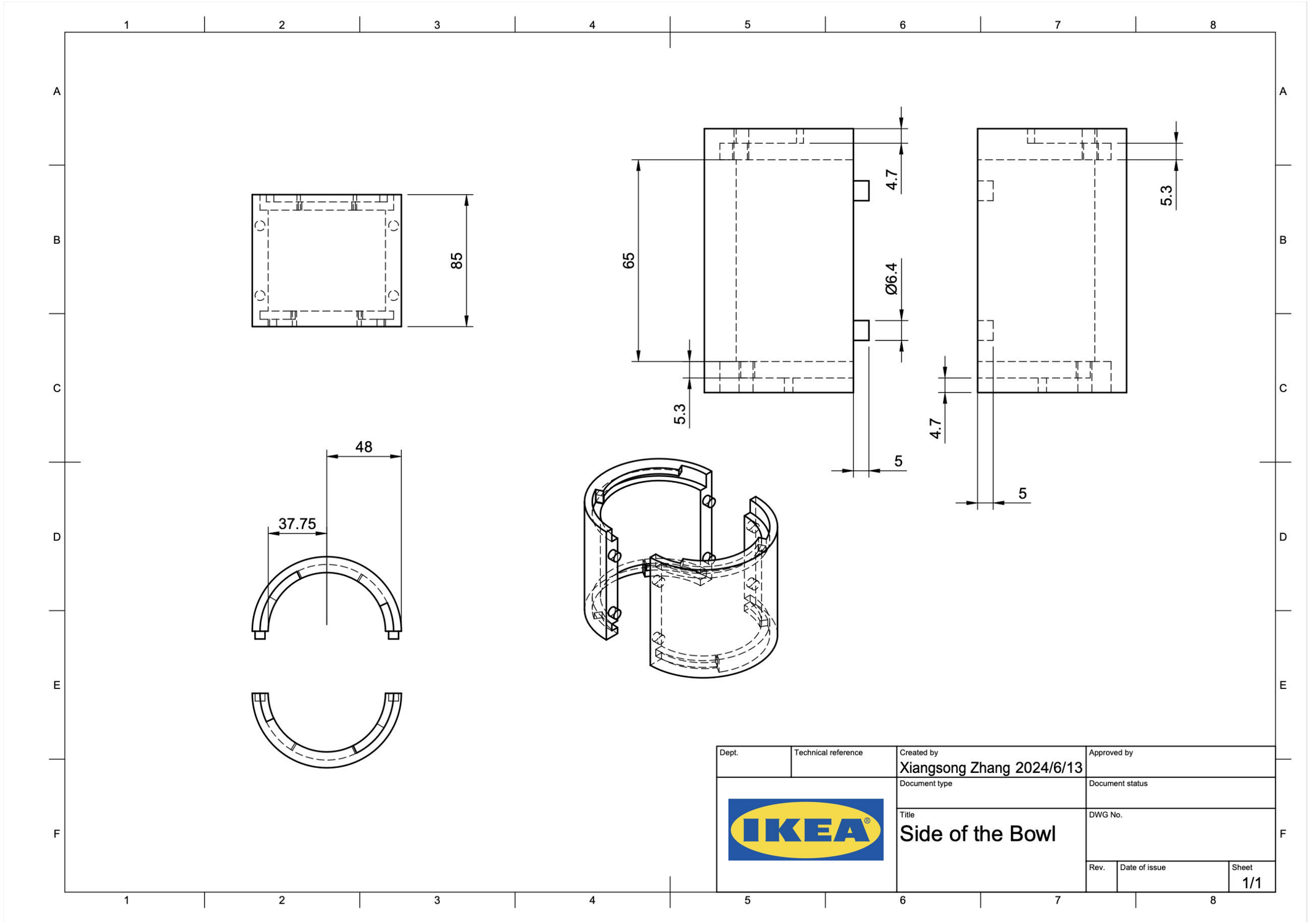
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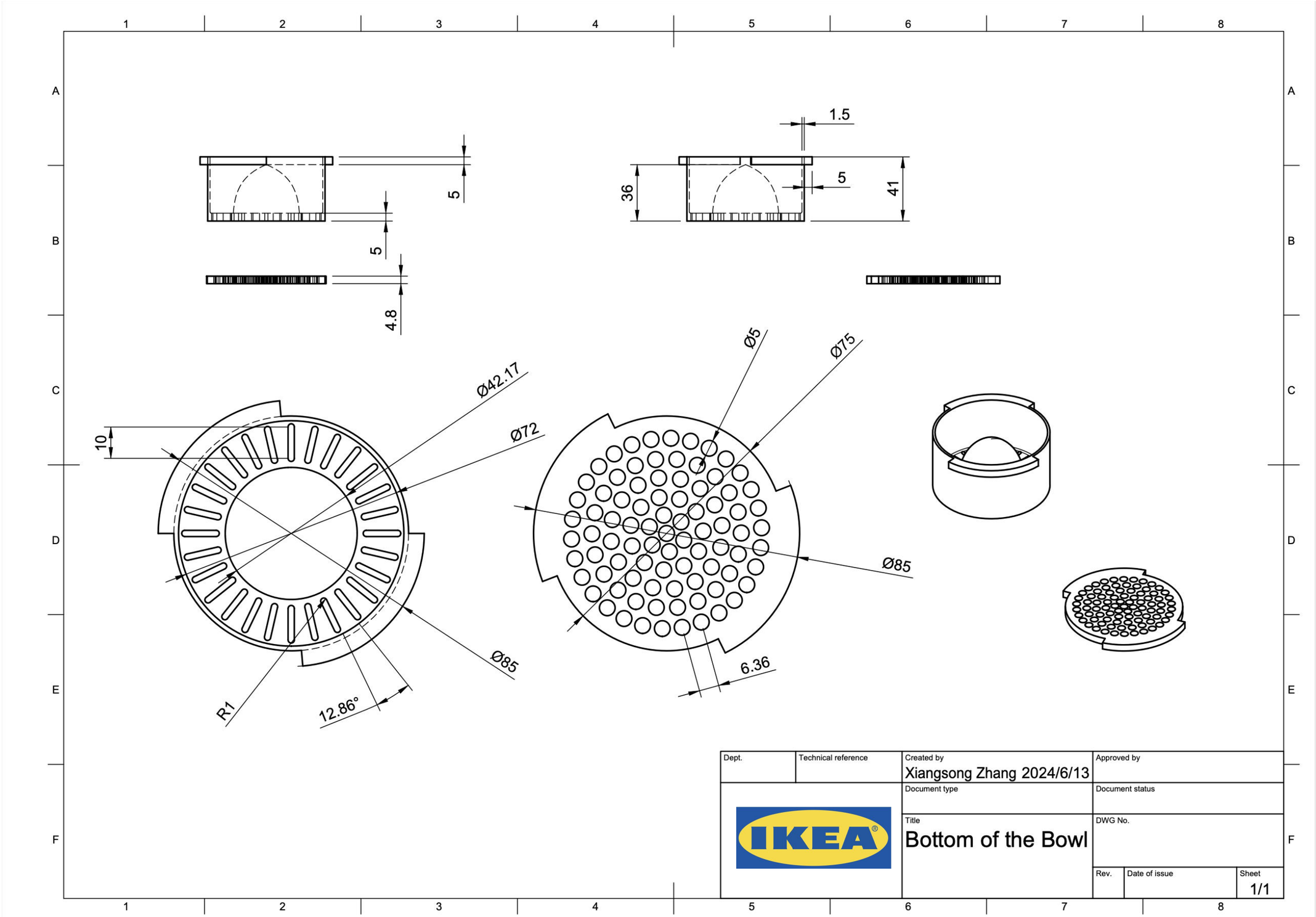
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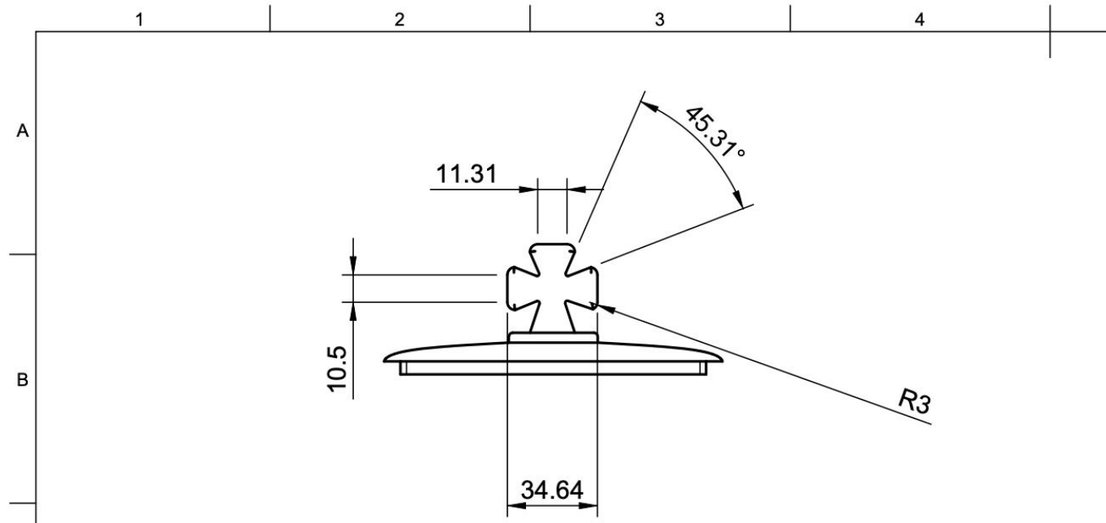


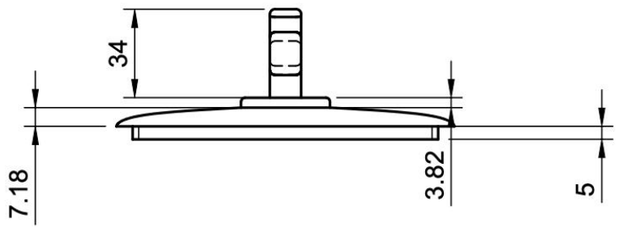
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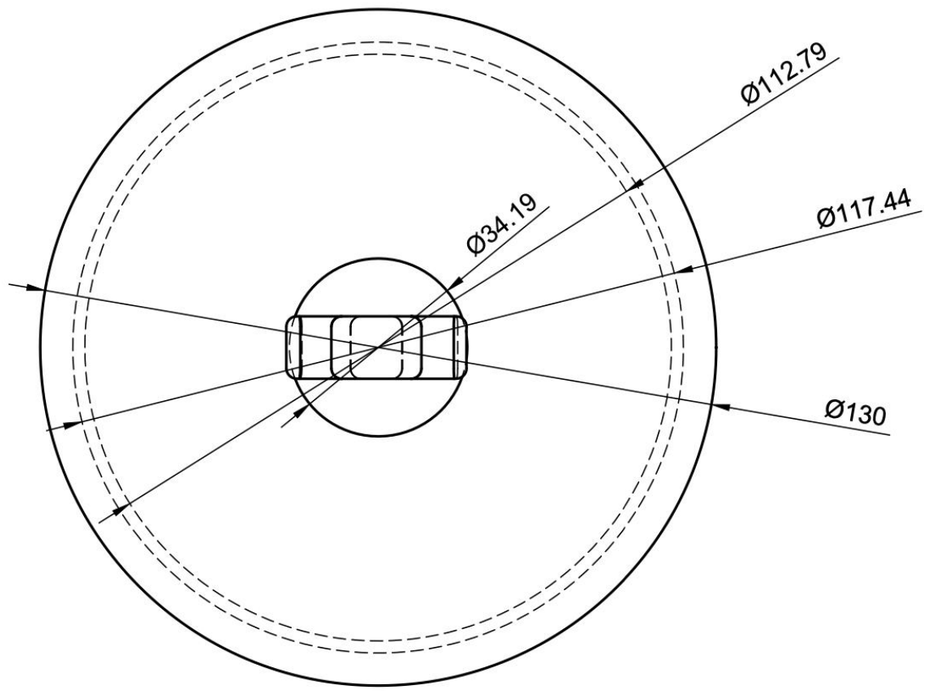


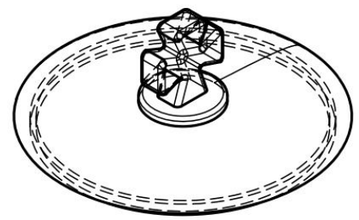
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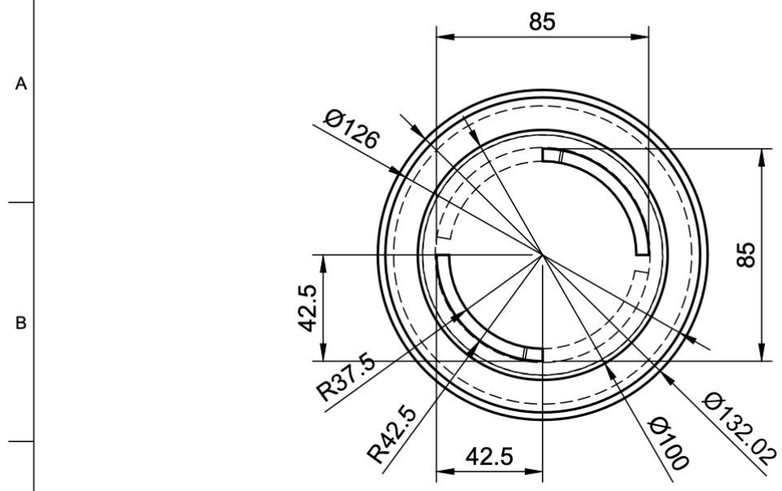


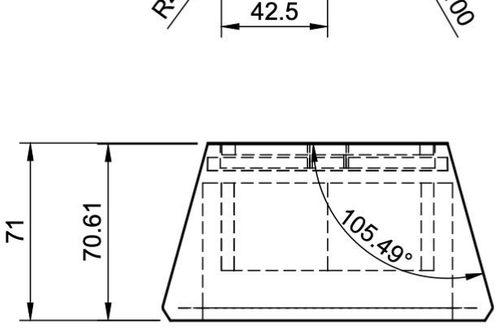


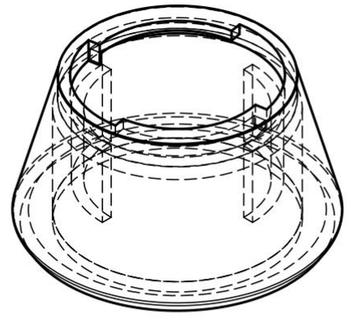


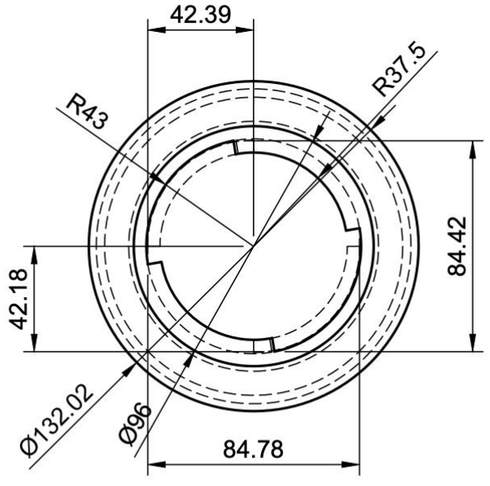
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PRODUCT DATA PACKAGE









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