

Think beyond the bin

DOOTI.

Challenging Throwaway Culture

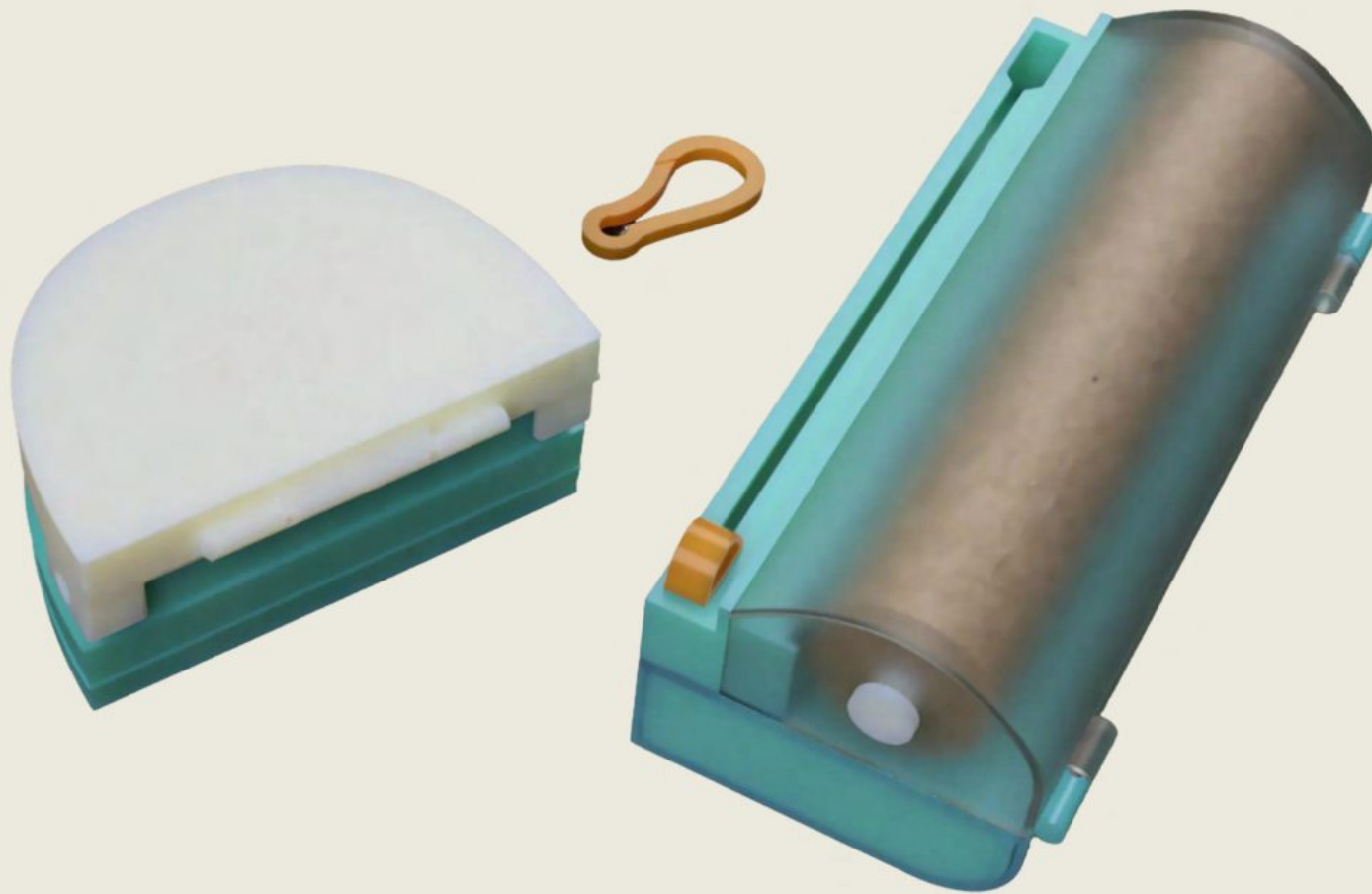
Yuxuan Zhou

Plaifah Chaisen

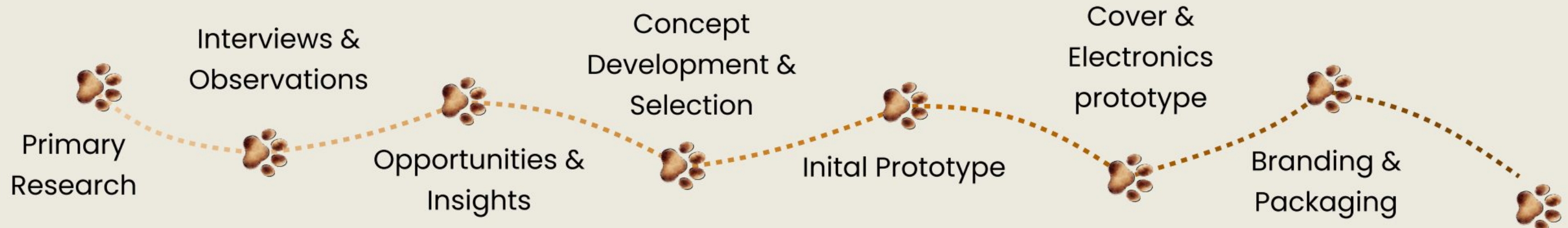
Zhixuan Song

Sirin Vivatanaprasert

01



Timeline



Conceptual Development

Purpose To **define** the rationale behind the product, its core functions, and its physical form through primary and secondary research.

Problem

- 1 Less than **5%** of dog owners compost their pet's waste where most "compostable" poop bags still end up in landfill. Home composting is **poorly supported** especially on walks.
- 2 Pet waste disposal is a largely **overlooked** issue, with misconceptions and a lack of public discussion contributing to poor disposal practices.



HMW

Encourage and educate pet owners to adopt safer, more sustainable waste disposal methods through a convenient, hygienic, and easy-to-understand system.

Selected Concept

A portable device that **dispenses, seals, and cuts dog waste bags** to a **user-defined** length. Thus, accommodating dogs of different sizes, reducing unnecessary material use and waste.

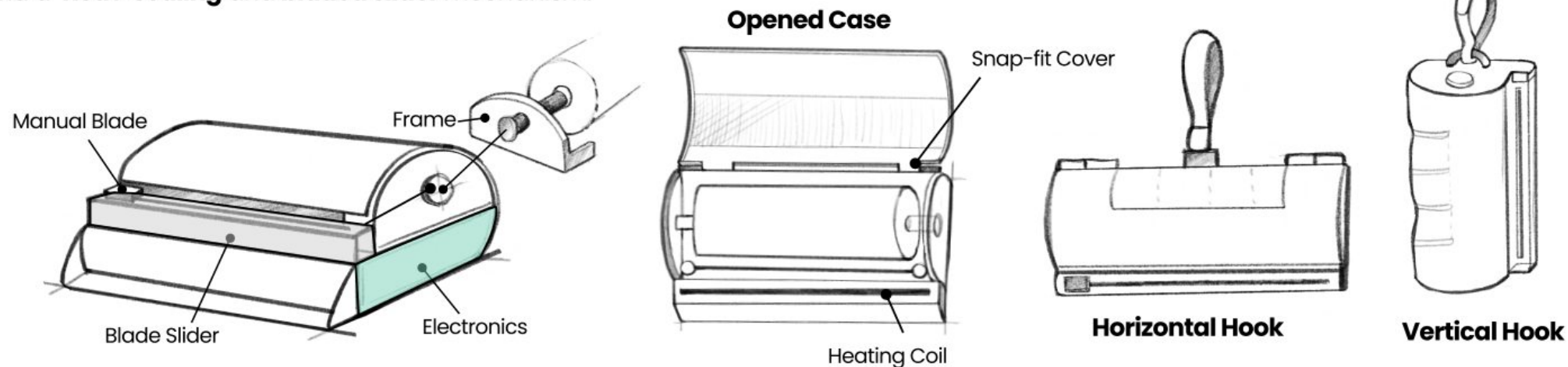


User group

Animal shelters, fosterers, and adopters who are open to adopting responsible and sustainable pet waste management habits

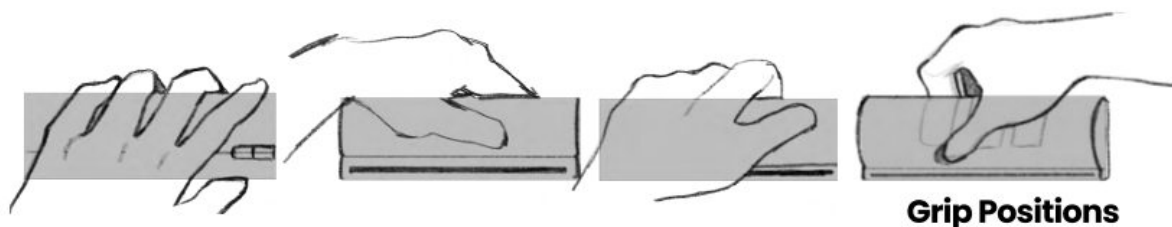
Main: Portable Bag Maker

Creates adjustable **variable-size** bags from rolls on-demand via a **heat-sealing** and **bladed slider** mechanism.

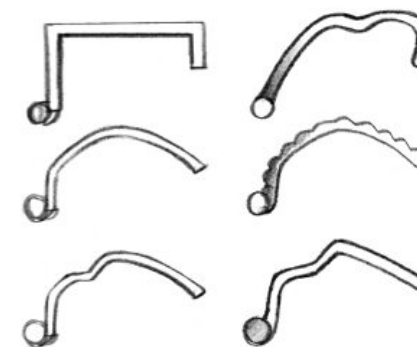


Inclusion & Ergonomics

Handling posture and grip position were developed through iterative sketching and validated through real-world user testing with participants from diverse demographic groups.



Grip Positions

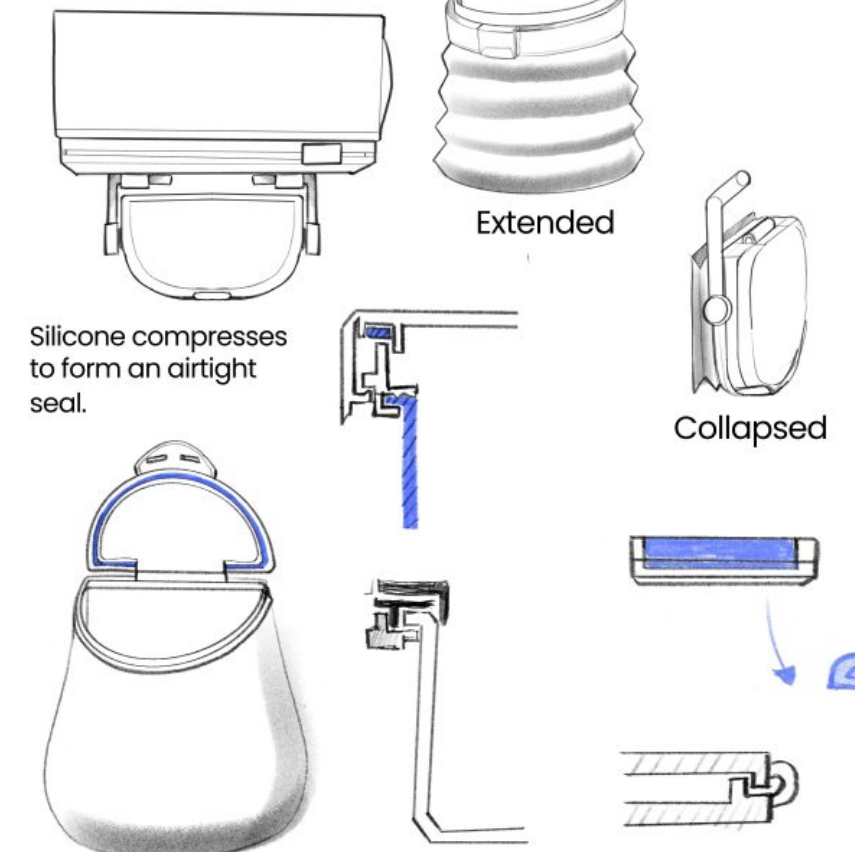


Cover Top View

Supporting: Smell-Proof Pouch

Storage system for multiple used poop bags for walks

Idea: Silicon Gasket



Development Journey

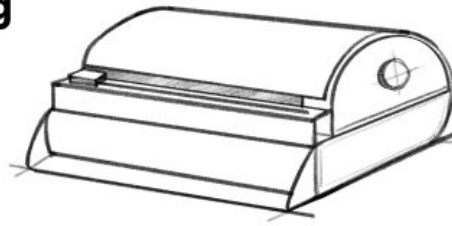
Purpose To give a **comprehensive overview** of our development process and user journey.

1. Key Functions

- 1** **Heat sealable** bags that can vary in size based on the poo size
- 2** **Odour-proof** and **water-resistant** bag (Leak proof with swinging)
- 3** Must be a **lightweight**, portable device designed for use outdoors (ingress, UV, moisture)
- 4** **Low cost packaging** that reflects DOOTI's eco-friendly and educational ethos

2. Concept Development

Sketching



Technical Planning



Branding Considerations



3. Physical Prototyping

Bag Maker



+10 Iterations

Odour-proof Pouch



+2 Iterations

Packaging



+4 Iterations

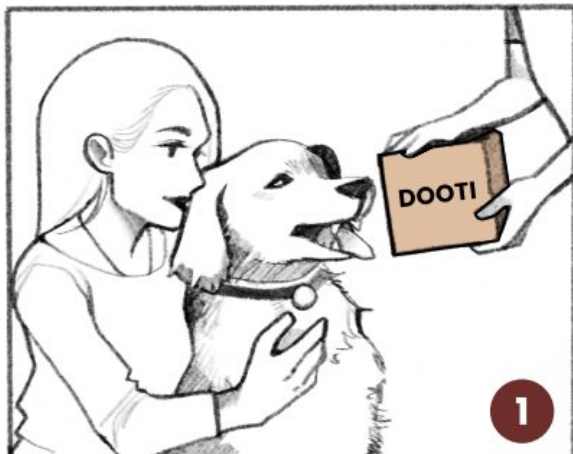
4. User Feedback

+70 user-feedback

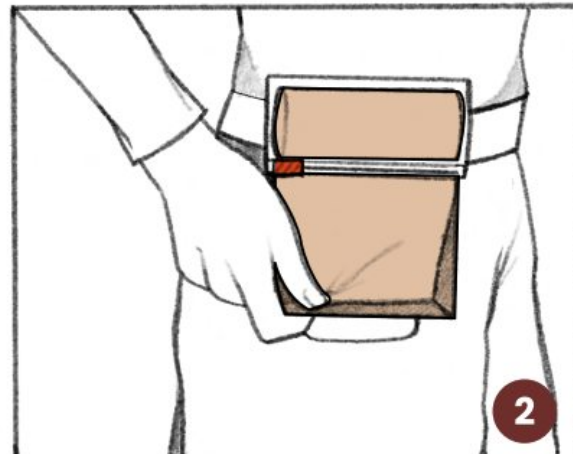
leading to +10 improvements



Storyboard : User Journey



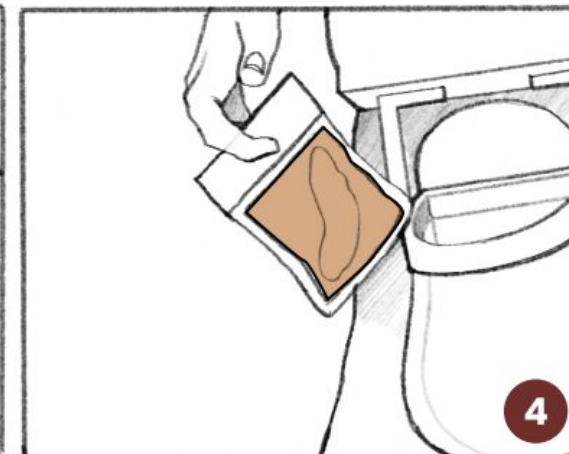
Users receive Dooti through an **animal shelter** and learn how to set up a dog-friendly **composting system at home**.



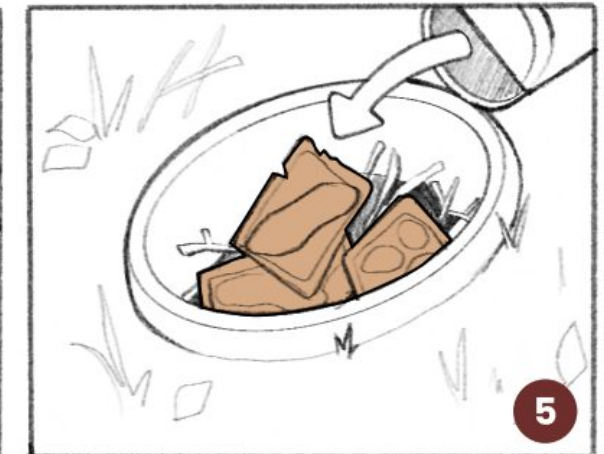
Users take the portable bag maker on walks and **dispense only the amount** of bag material needed to collect the waste.



Once cut, the bag separates into two parts. The paper sheet is used to pick up the waste, which is then placed inside the cellulose bag.



Used bags are stored in the **smell-proof pouch**, providing hygienic and convenient containment during the walk home.



At home, the contents are **tossed into a compost heap**, where microbial activity breaks down the waste, reducing pathogens and creating nutrient-rich compost.

Physical Prototyping

Purpose To **summarise** the iterative development of the three core components: Bag Maker, Refill Roll, and Pouch.

Portable Bag Maker

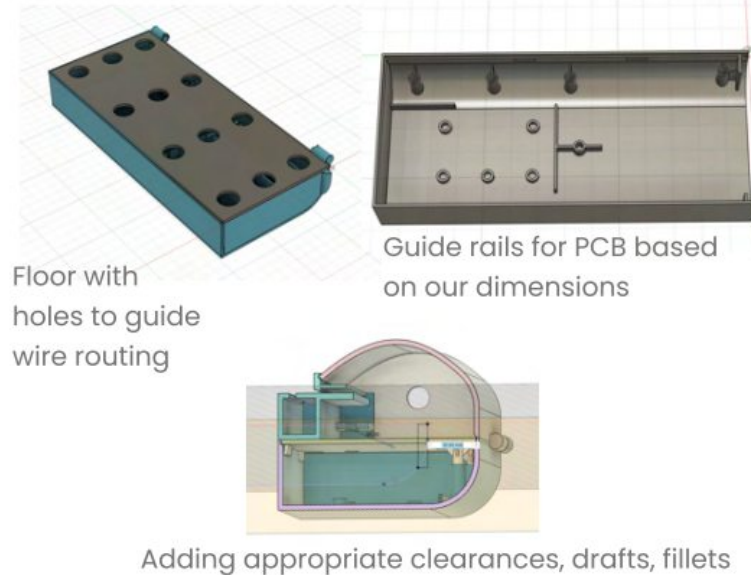
+3 Looks-Like Prototypes



+6 Lid & Cover



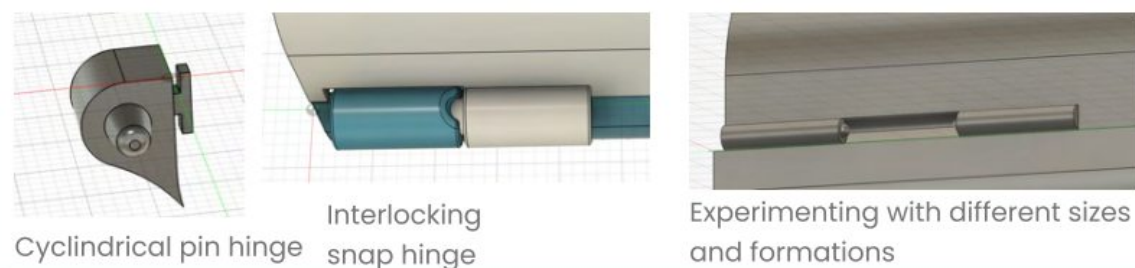
+8 DFA Adjustments



+4 UX Features



+4 Hinge Designs for Lid



Bag Roll Refill

We prototyped the refill rolls by sandwiching layers of cellulose film and the masking paper together then rolling it around a core. The total length is **4m** per roll.

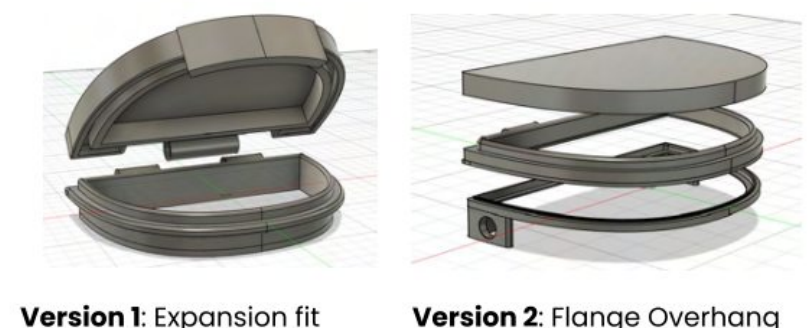


Ordour-free Pouch

We modelled the **silicone component** of the smell free pouch using a 2 part mould and shore with wall thickness of the prototype chosen to be **1.5mm**



The mould was cut to release the silicone due to excessive friction at the sides.



Electronics Prototyping

Purpose To provide an initial understanding of both the physical structure and electrical considerations before making the real model.

Load Calculations

Heat Sealing

Provides power to the heating element through the MOSFET switch.

Circuit Diagram



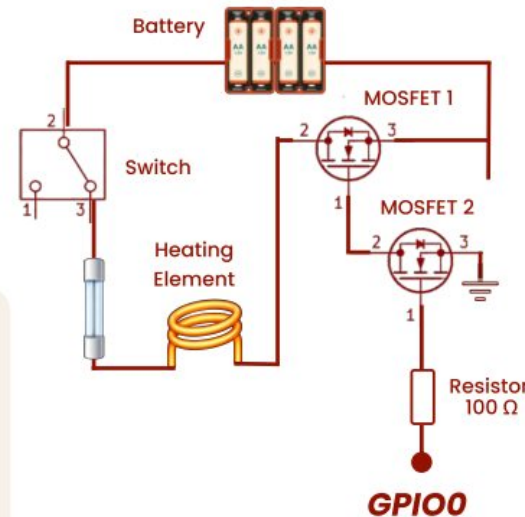
Heat Power

$$P_{he} = \frac{7.4^2}{5} = 10.952W$$



Mosfet Power

$$P_{mosfet} = 2 \times \frac{3.3^2}{10000} = 0.002178W$$



Microcontroller

We chose the Raspberry Pi Pico to read ADC Inputs and control the MOSFET on/off states.



$$P_{pico} = 3.3 \times 0.35 = 1.155W$$

Total Power

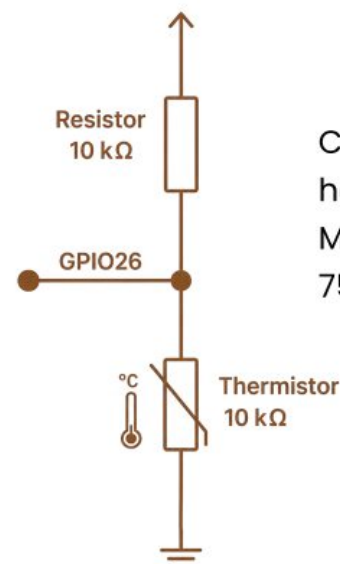
$$P_{sum} = P_{he} + P_{pd} + P_{pico} + P_{mosfet}$$

$$P = \frac{V^2}{R}$$

$$P_{sum} = \frac{7.4^2}{5} + \frac{3.3^2}{3000} + 3.3 \times 0.35 + 2 \times \frac{3.3^2}{10000} = 12.11W$$

Potential Divider

Converts the thermistor's resistance change into a voltage signal that the Pico can read.



Cuts power to the heater via the MOSFET near the 75°C safety limit.

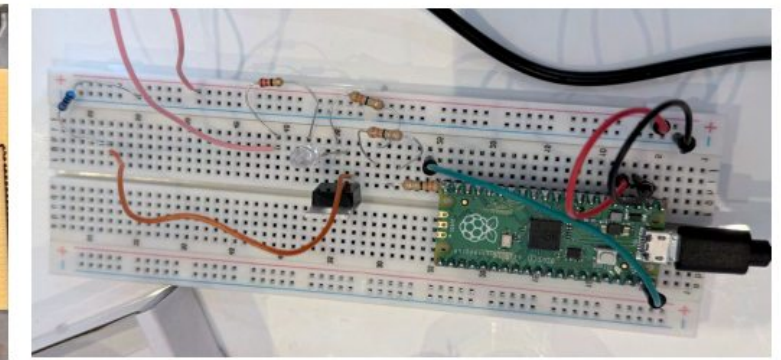
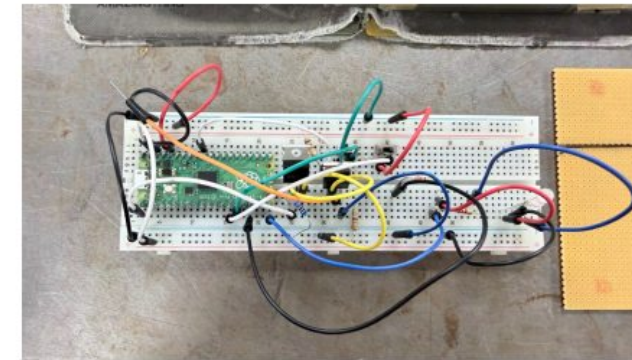


$$P_{pd} = \frac{3.3^2}{3000} = 0.00363W$$

Implementation

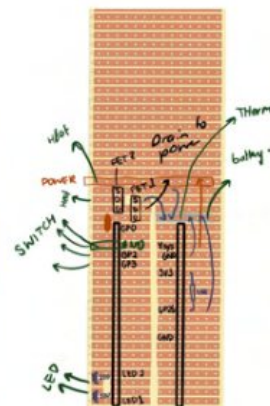
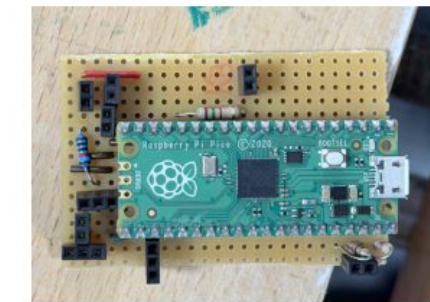
Iteration 1: Breadboard

The initial circuit was built on a breadboard for easy to **planning** and **alterations**.



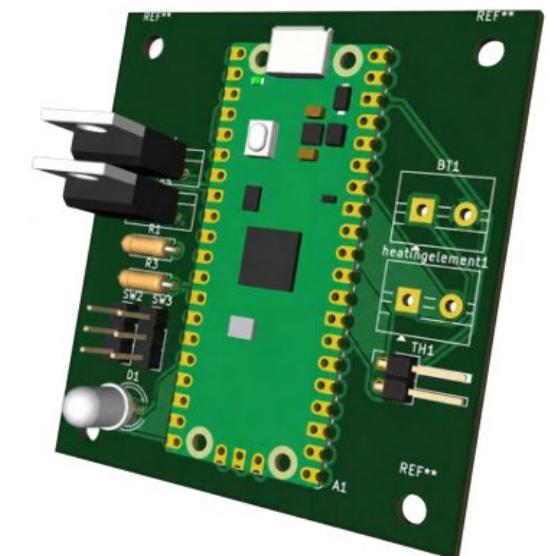
Iteration 2: Stripboard

To **optimize space**, the circuit was transferred to a stripboard to replicate the compact footprint of a PCB. Tracks were routed to minimize board area, while **female headers** were used to allow easy component replacement.



Next Steps: PCB Design

In deployment, a PCB board would replace the strip-board. We transitioned our circuit to PCB form using **KiCad**.



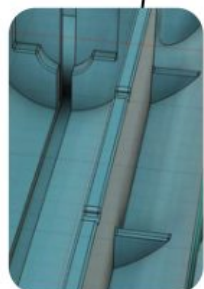
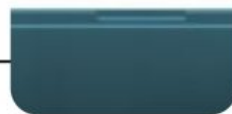
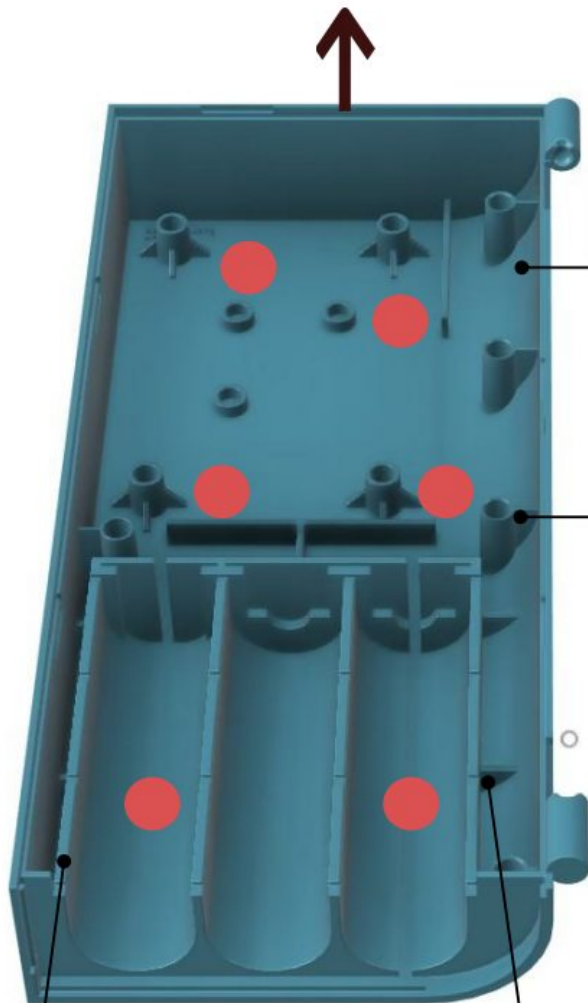
DFMA Considerations 1

Purpose To summarise the key features that was developed in consideration to injection moulding.

Key Features

Features align with injection moulding pull direction

- Minimises undercuts



Strengthening ribs: 0.9mm thick, 4mm tall

- Increases structural rigidity
- Reduces material volume required to increase wall thickness

Draft angle: 1° for all vertical surfaces

- Supports mould release

Ejector pin locations:



- Evenly distributed
- Located near stiffer regions
- Non cosmetic surfaces

Standard injection moulding tolerances are applied to non-critical enclosure features

Nominal Wall thickness: 1.5mm

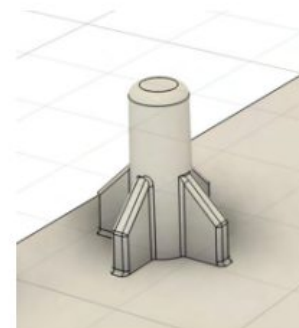
- Reduces cooling time & material volume
- Consistent thickness reduces warping

Bosses wall separation: >3mm

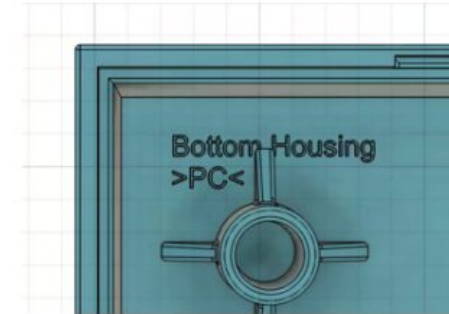
- Reduces sink marks
- Supported with ribs

Fillets: 0.2–2mm

- Minimum 0.2mm fillet to facilitate mould removal and reduce stress concentration
- Larger fillets for mating parts such as bosses and alignment pins

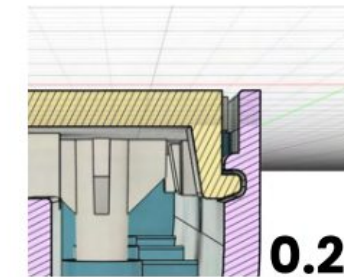


Material Labelling



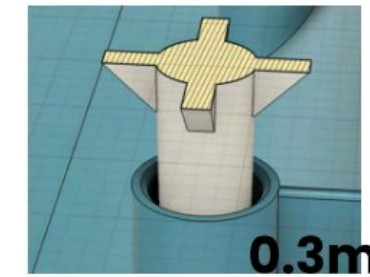
- Part identification
- End of life material identification for recycling

Snap fit Clearance



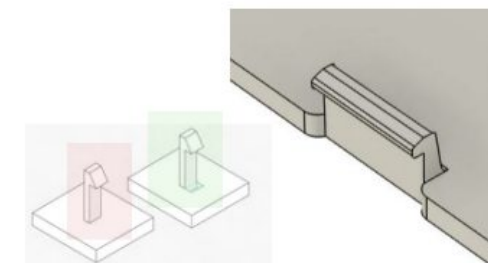
0.2mm

Boss & Pin Clearance



0.3mm

Undercut Consideration



Openings incorporated beneath snap fit cantilevers to eliminate moulding undercuts

Nominal Assembly Clearance:

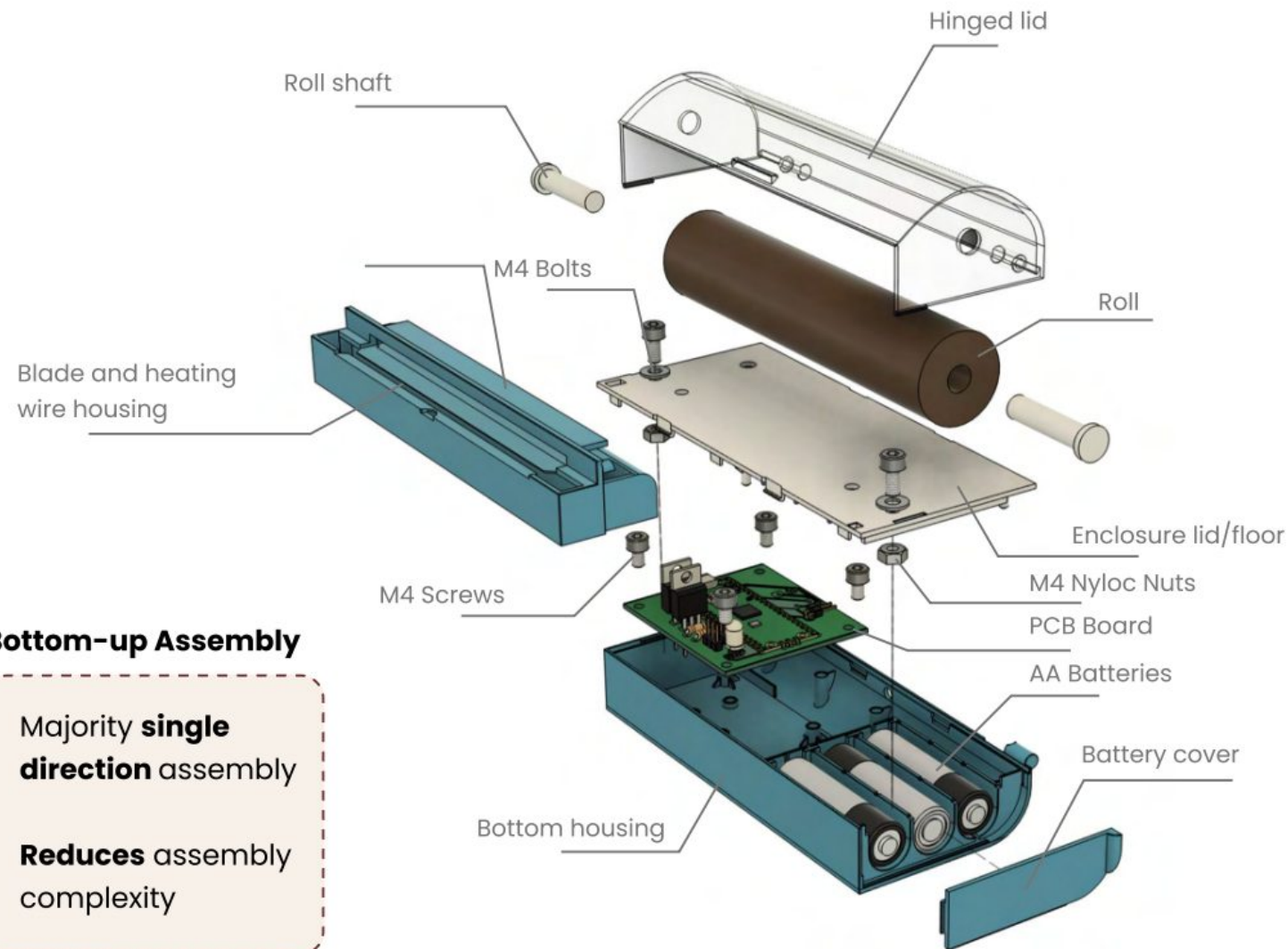


0.1mm

DFMA Considerations 2

Purpose To provide an **overview** of all **product components** and clearly communicate the **step-by-step assembly process**.

Exploding Diagram



Bottom-up Assembly

Majority **single direction** assembly

Reduces assembly complexity

Single Standardised Fastener

Only uses **M4 fasteners** to reduce tooling requirements and part variety

Alignment Features

Pins and Bosses
Lips and locating tabs
Guide ribs for wire routing and PCB placement

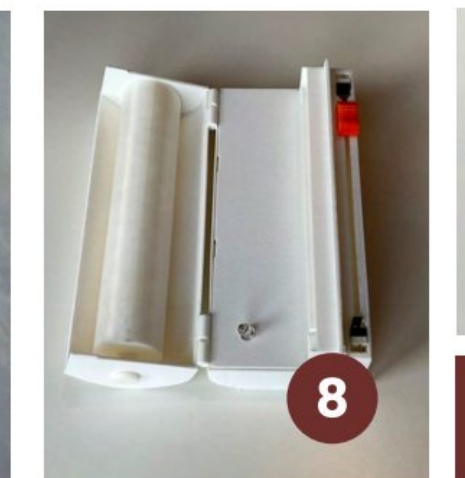
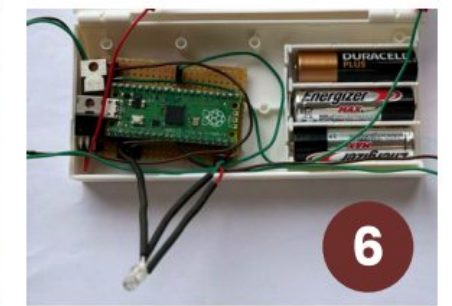
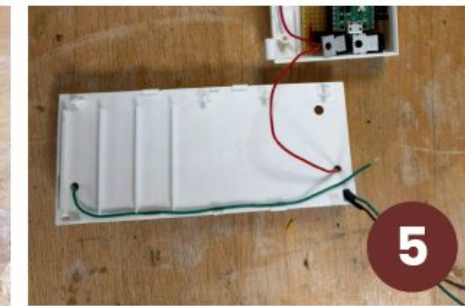
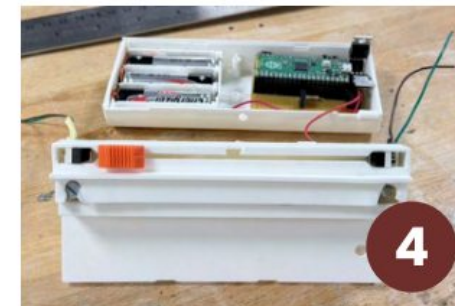
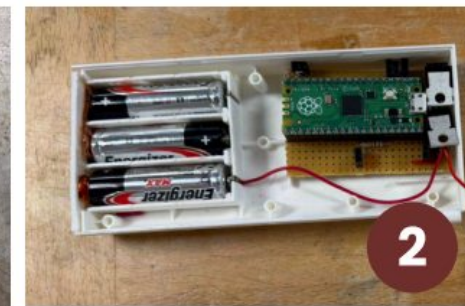
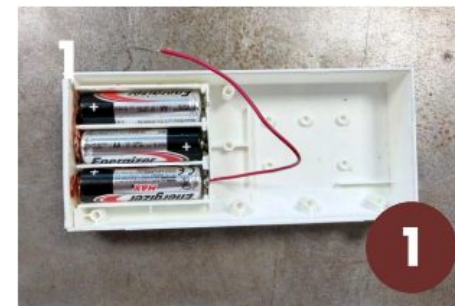
Snap-fit

Main fastening system to **reduce fastener count**

Used to connect both the hinged lid, floor, and battery cover

Assembly (Portable Bag Maker)

Total Assembly Time: **20 mins** (pre-soldered electronics)



end

User Feedback & and Validation Testing

Purpose

To gather **constructive user feedback**, **validate key design decisions**, and identify opportunities for further improvement.

The Great Road Festival: Direct User Feedback

GERF User Participation

To **evaluate usability**, participants were asked to **pick up brownie "dog poo"** using Dooti without instructions.

Of the approximately **70** attendees interviewed, **only four** reported **composting**.

Pick-up Test

Most participants instinctively used a **scooping** motion but **struggled** to transfer the waste efficiently, prompting a **redesign** of the bag geometry.

Orientation

Most participants preferred a **downward pulling** motion



Inclusion Testing

We evaluated the product's ability to collect imitation dog waste across a **range of sizes** and **moisture levels**, reflecting the variability encountered in real-world use.



Early Stages of Diarrhoea

Expedited Compostability Testing : Pineapple Enzymes

A homemade pineapple enzyme solution was used as a **compost accelerator** by exposing cellulose film samples to the solution. The results of the test provides an accelerated indication of how the material may degrade under enzyme and microbes assisted composting conditions.

Source



Fermentation



Exposure



Results



Result Summary

Compostability

Visible degradation in the tactile properties of the cellulose film was observed. However, longer-term testing in a controlled composting environment with elevated temperatures is required to accurately assess its composting rate and overall degradation timeframe.

Moisture Level

Can collect wet waste up to a point; however, highly liquid waste may require users to absorb it with grass or similar material before collection.

Extreme Turd Sizes

The 12 cm bag opening can make insertion of larger deposits more difficult, though the system performs effectively for most small to medium-sized waste.

Dooti x Battersea Dog and Cat Home Brand Collaboration



Purpose

To establish a **brand identity** with **Battersea Animal Home**

Brand Identity

Shared Mission

Promoting **responsible pet ownership** through **education** and **practical support**, creating lasting benefits for pets, communities, and the environment.

By reaching owners at the start of their journey, we aim to foster lifelong **responsible waste disposal habits** and empower **informed choices** about what they choose to support.

Target Audience

Socially-conscious Owners and Fosterers

Choosing to adopt from a shelter reflects a **commitment to responsible pet ownership** and animal welfare. This makes adopters and fosterers a particularly **receptive audience for education** on sustainable pet care practices, including the proper disposal and composting of dog waste.



Battersea Primary Palette



Dooti Secondary EarthTones

Shared Values

- 1** Pet ownership is a **long term commitment** not a transaction
- 2** We empower and educate owners to make informed decisions, **not to shame** them.
- 3** Pet ownership carries a responsibility not only to the animal, but also to the **people and environments it affects.**

Branding Implementation



3-Step Campaign



To balance branding, function and purpose

CMF Considerations

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Purpose To explain how the product's colour, material, and finish reflect and reinforce our brand values.

Lid & Case: Finish & Colour

Grainy Top



Lid Texture

- Grainy lid improves grip for gloved and one-handed use.

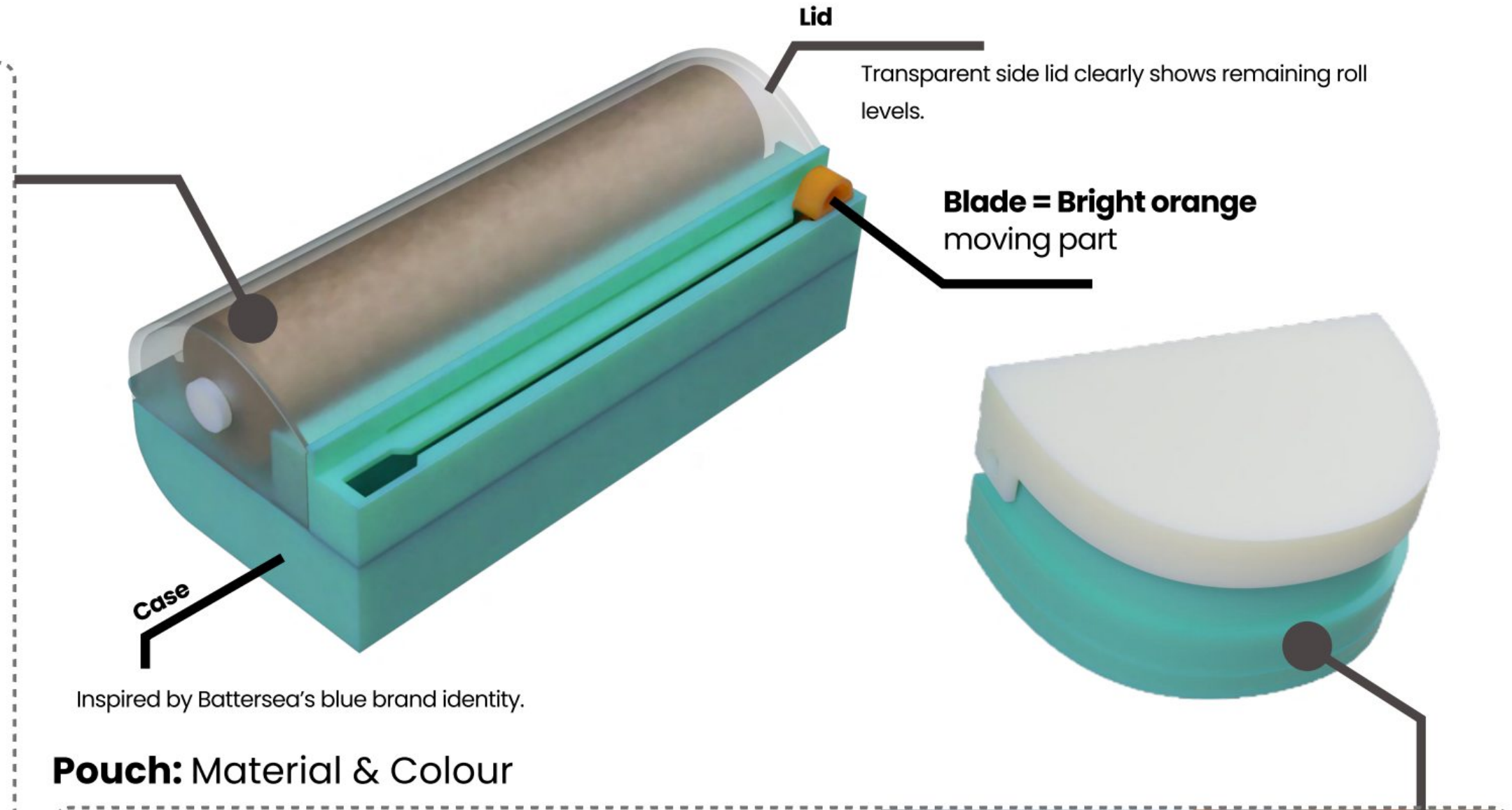
Transparency

- Transparent lid allows LED visibility, indicating when the heat seal is active.



Colour & Surface Finish

We evaluated a range of fuzzy-skin textures to identify the optimal surface finish that provides secure grip while minimising dirt adhesion.



Pouch: Material & Colour

Prototype: Shore 20A Silicon

Production: Shore 30A (Higher structural stiffness)

- Conceals waste while maintaining enough visibility to encourage responsible disposal.
- Flexible enough to be inverted for easy cleaning and pushing waste out of pouch.
- **Blue silicon:** Signals waste containment and contrasts with natural surroundings.
- **White lid:** Highlights dirt and encourages regular cleaning to reduce contamination.



Compliance Labels & Educational Product Information

User Guide & Branding

11

Purpose To educate and inform user how our product functions

Composting Safety

Infographics

Product Instructions

Collaboration Postcard

Product Instructions

DOOTI'S

calling you



user guide



1 What's in the box



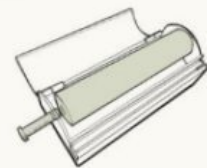
Key User Features

- 1 Heat Sealing & Bag cutting Mechanism
This is how we make the bags.
- 2 Smell-proof and Leak-proof Pouch
Great for transporting home.
- 3 Wash hands thoroughly
After dealing with compost and keep away from kids.
- 4 Source your Turds
Know your Supplier
Compost only firm, healthy poo.

Set Up

TIP: Your Dooti portable bag maker should be preloaded with a roll

Inserting the Roll



Attaching the Pouch



2 HOW TO USE



TIP: Only pull the amount of material needed to minimise waste

Refill

We've included three refill rolls in the box, so you're ready for plenty of walks ahead.

Need more? Visit [Dooti.com/shop](https://dooti.com/shop) or pick some up from one of our shelter partners.

Every purchase helps support animal shelters, turning your dog's deposits into a positive contribution for dogs still waiting for their forever home.

Care & Safety

- 1 Avoid Excessive Moisture.
Do not submerge in Water.
Dooti can handle walks & rain but it can't swim.
- 2 Store Rolls in Dry Place.
Keep out of Children's reach.
Dooti bags use paper and cellulose materials that may degrade faster when exposed to humidity.
- 3 Heating element surface may be hot.
Do not remove the safety shielding or expose internal heating and cutting components during operation.

Composting Guidance

Don't know where to start? We'll help you.

Dog poo can contain unwanted guests such as Salmonella, E. coli and tapeworms. Luckily, when composted correctly, microbes generate heat that helps kill these pathogens while transforming waste into nutrient-rich black gold. We've simplified the essential rules below, but for a complete step-by-step composting guide, visit our website!

Essential Rules

- 1 Use a dedicated pet waste compost system.
Have separate systems for normal & dog compost.
- 2 Do not use compost for edible plants.
Reduce contamination risk by not eating it.
- 3 Wash hands thoroughly.
After dealing with compost and keep away from kids.
- 4 Source your Turds.
Know your Supplier.
Compost only firm, healthy poo.

Taking it a step further: Is your dog...

on medication?



Veterinary drug residues like common flea/tick treatments, are excreted in faeces and may persist in the resulting compost.

on a raw diet?



Dog poop from a raw diet are more likely to contain higher amount of Salmonella or resistant E. coli.

under 1 year?



Puppies are more prone to parasites like Giardia and roundworms due to their undeveloped immunity.

Turd Chart

Not all poops are excreted equal

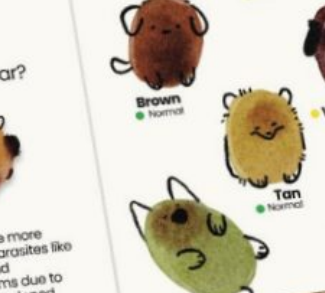
Do compost...



Round & Hard

Avoid composting...
Runny & Watery

Colour Meaning



Turd Chart

Educational Display

Guides users to assess which type of turd should be composting with minimal risks.



Design Intentions...

A key ethos of Dooti's branding is to **raise awareness** and **spark conversations** about the benefits of composting dog waste, while remaining transparent about the potential risks and responsibilities involved.

Our aim is for users to share what they learn with others, extending awareness beyond the product. The playful user guide encourages users to keep and display its cover and back pages rather than discard them.

Designing for Circular Life & Disposol

Packaging & Label Design

Purpose Create **effective packaging** for our **user group** and **requirements**.

Core

Dooti's packaging was designed to be **low-cost** and compatible with both **recycling** and **composting** streams. By reflecting the product's **circular ethos**, the packaging remains sturdy for transport.

Paper Sleeve

Mailer Box

Dieline Production

assigned to be low cost and compatible with both **recycling** and **composting** streams. By reflecting the product's **circular ethos**, the packaging remains sturdy for transport.

Mailer Box
Dieline Production

Material Separation

QR Code
Provides access to product information

QR Code to Website

Provides access to supplementary product information.

Producer Information

Promoting responsible pet ownership through education and practical support

End-of-Life Instructions

Promoting responsible pet ownership through education and practical support

Warnings

Compliance Labeling

Compostability Labels

1 Paper

2 1/2 Model

Cardboard

Dieline

Internal (Side)

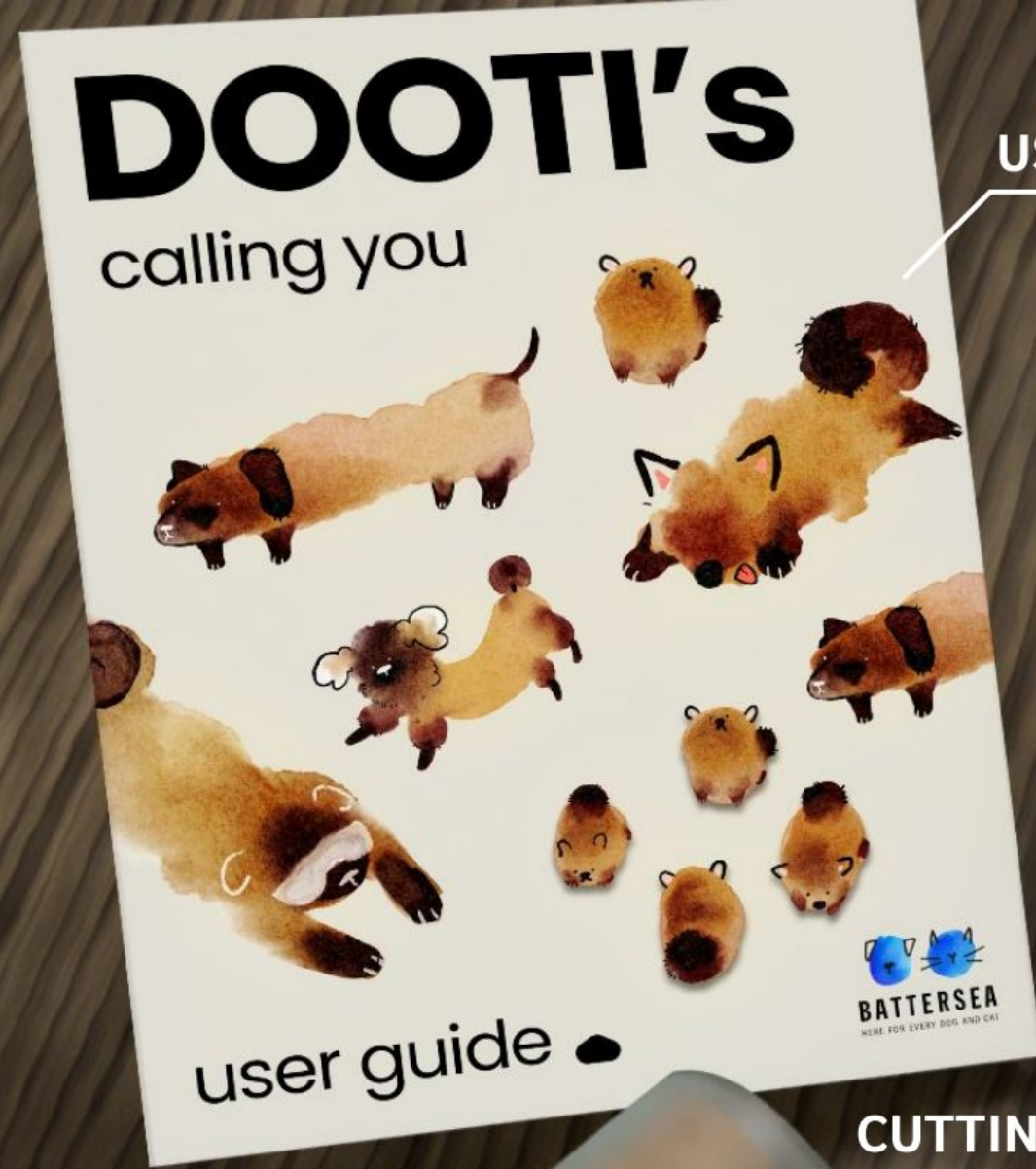
Display (Upright)

Securement Test

TESTING

12

13



USER GUIDE



CUTTING SLOT

CLEAR LID

CUTTING BLADE

AIRTIGHT LID

HOOK

DISTRIBUTED BY ANIMAL SHELTERS

Final Design



COLLAPSIBLE POUCH



REFILL ROLLS

BRAND PACKAGING

Think beyond the bin

DOOTI.

Challenging Throwaway Culture

PORTABLE

REFILLABLE BAG ROLLS

2IN1 SEALER & CUTTER

ODOUR-PROOF POUCH

An alternative to one-size-fits-all waste bags

Portable Dog Poo Bag Maker

Designed for Composting Dog Turd.

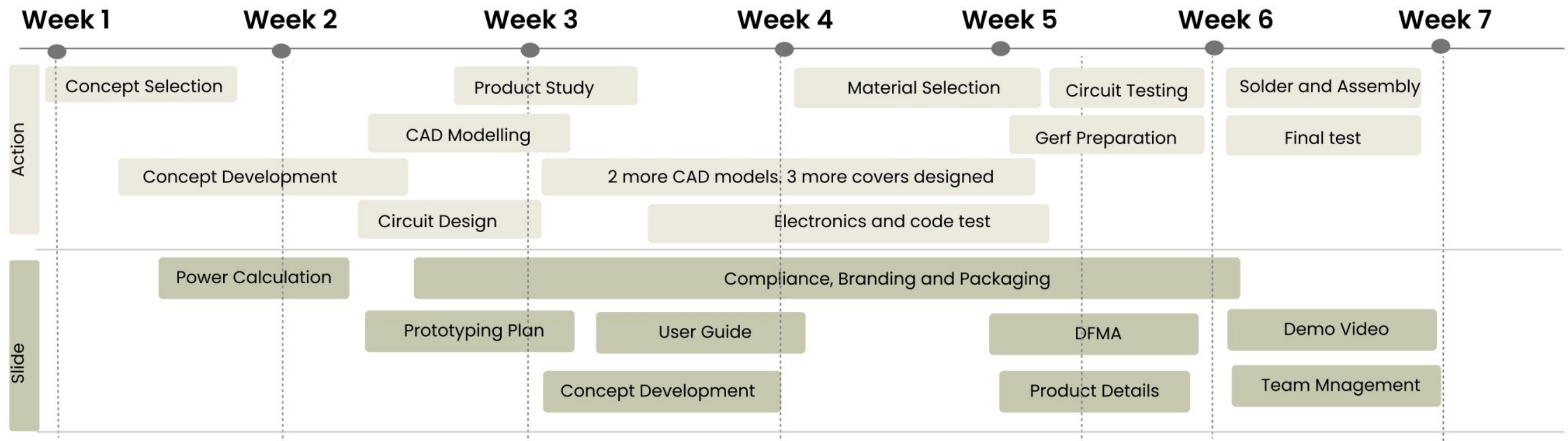
The Project Timeline

Activity flow

15

Purpose Project workflow planning and team responsibilities.

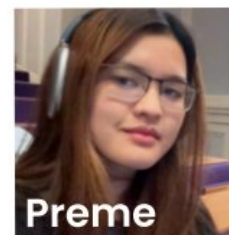
Key: Action Documentation



Our Team: Group 14



CCO



Brand storyteller & visual lead.
Turns ideas into posters, packaging, user guides, and a clear product identity.

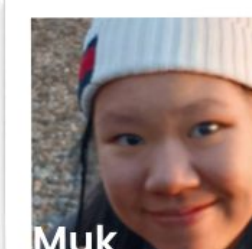
COO



Coding and electronics lead.
Builds the control logic, tests circuits, and keeps the technical system working.



Team organiser & prototype maker.
Tracks plans, budget, while helping with testing, soldering, and materials.



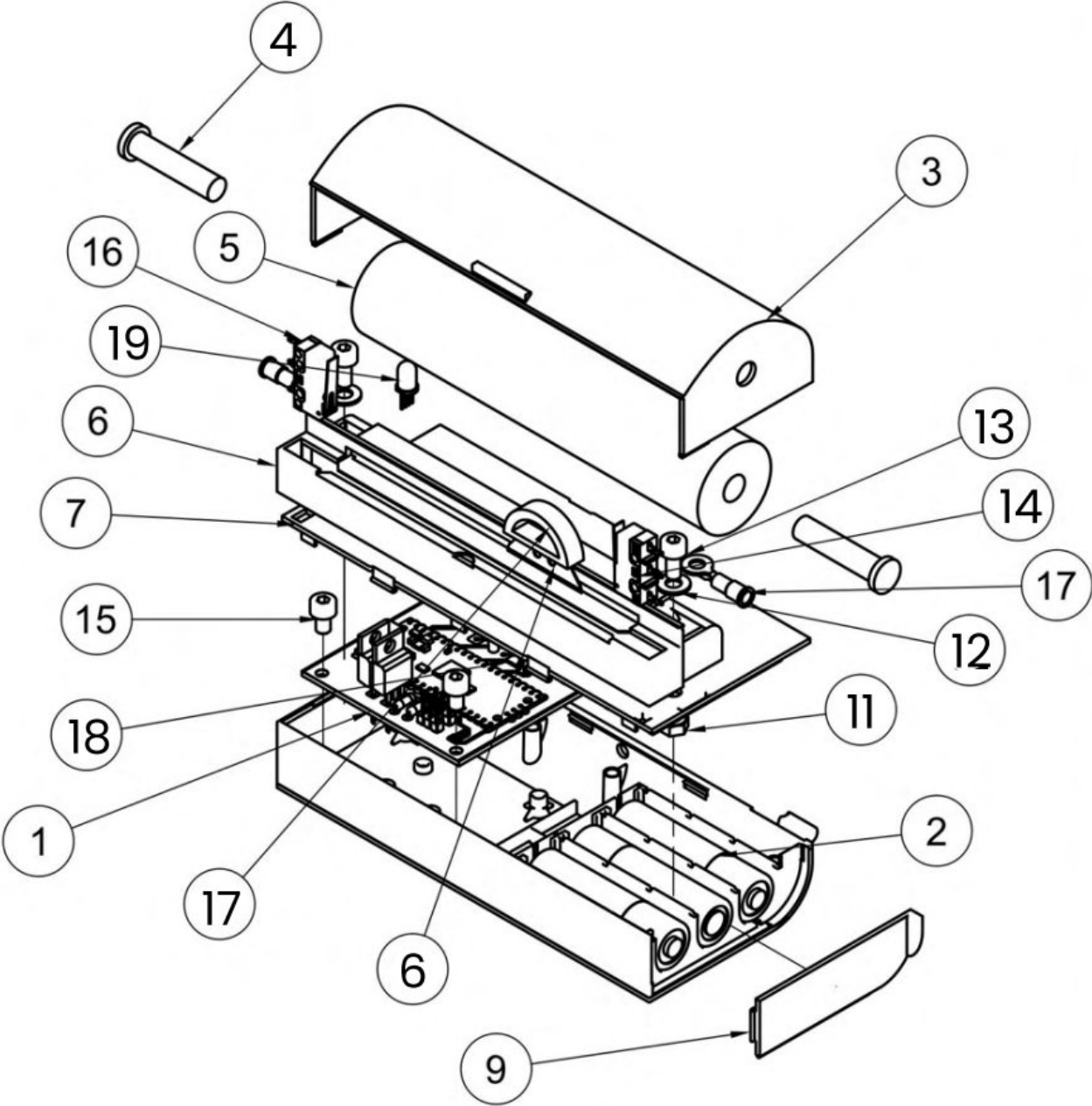
Prototype explorer & CAD Modeller.
Develops CAD models, supports circuit testing, and turn the design into a model.

COO

COO

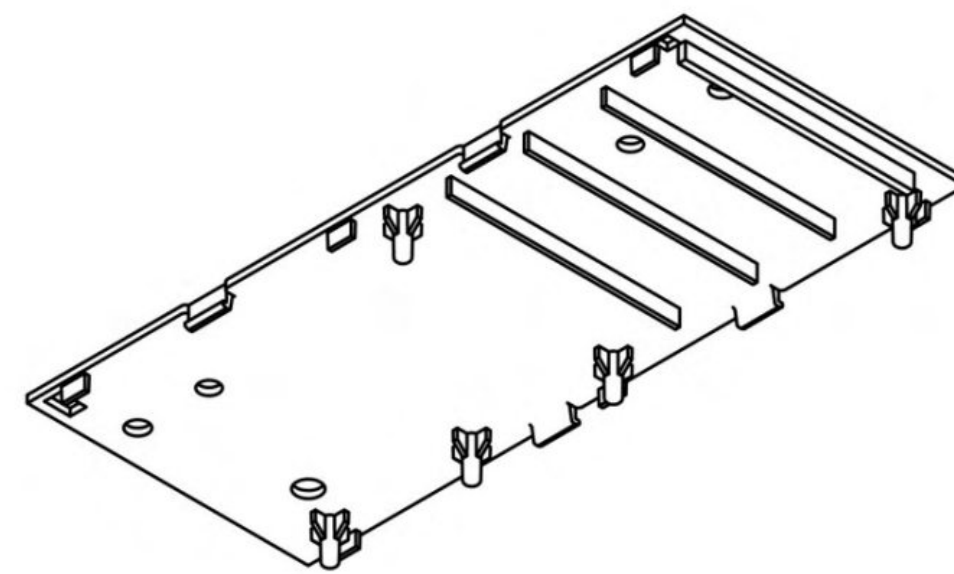
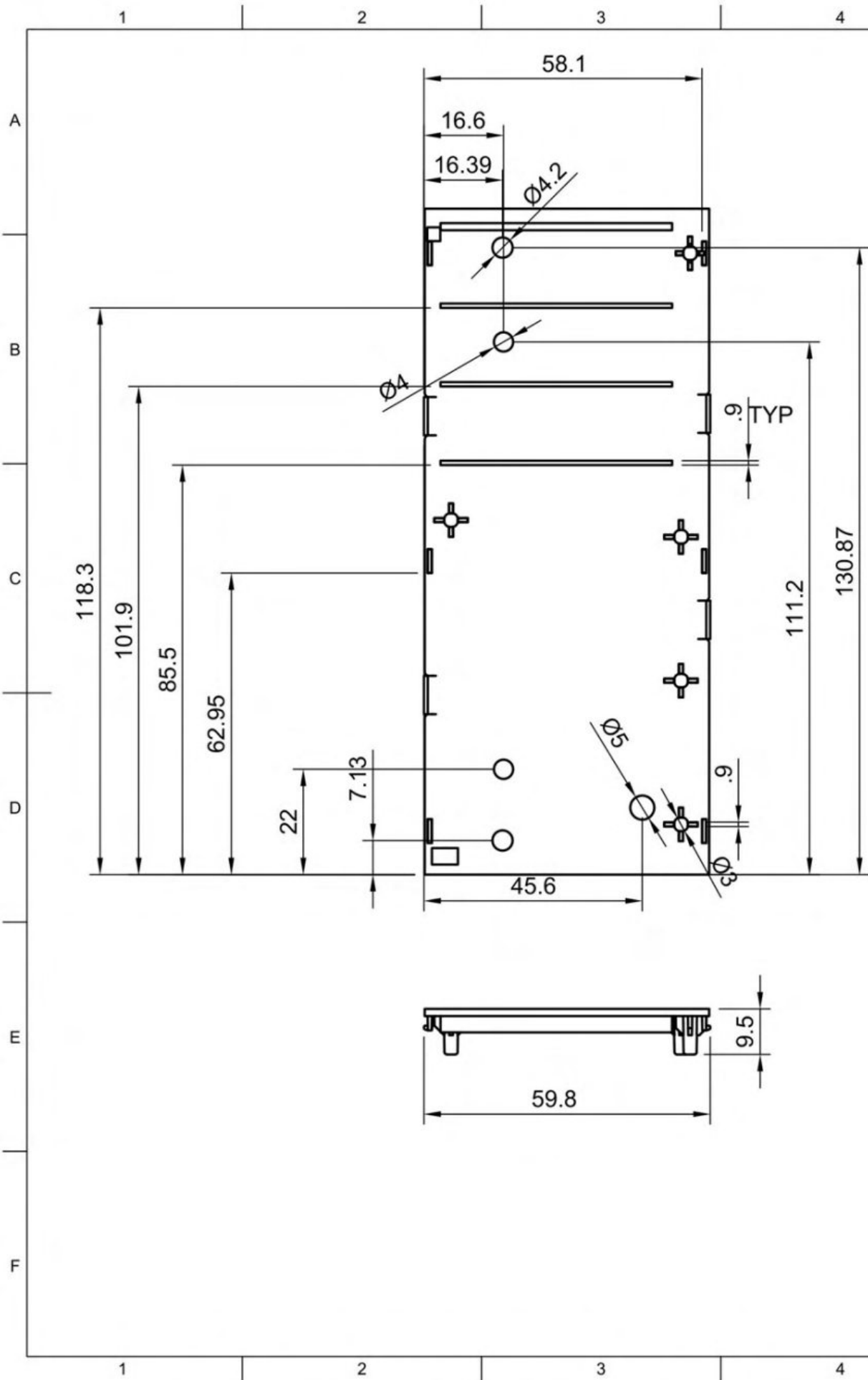
Appendix

Parts List				
Item	Part Name	Qty	Material	Cost in Pounds (total)
1	PCB Assembly [2*Mosfet, 1*Rasberry Pi Pico]	1		3.60
2	AA Batteries	3		0.75
3	Clear Lid	1	PC	0.30
4	Roll shafts	2	PC	0.12
5	Roll	1	Paper/Cellulose	0.50
6	Switch/Blade Housing	1	PC	0.55
7	Enclosure floor/lid	1	PC	0.40
8	Battery cover	1	PC	0.15
9	Bottom enclosure	1	PC	0.75
10	M4 Bolt	2	Steel	0.04
11	M4 Nut	2	Steel	0.02
12	M4 Washer	2	Steel	0.01
13	M4 Screw	4	Steel	0.08
14	7658K211_Subminiature Snap-Acting Switch	2		0.50
15	7113K611_Tin-Plated Copper Ring Terminals	2		0.05
16	Blade	1	Steel	0.10
17	Blade grip	1	PC	0.10
18	Thermistor MF58 3950B 5% 10k Ohm	1		0.15
19	RGB LED	1		0.05

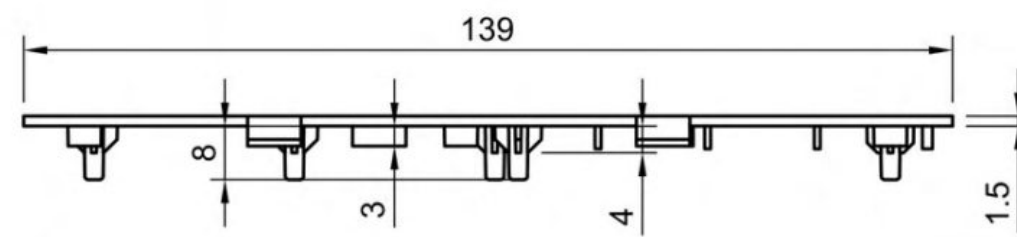


Dept.	Technical reference	Created by Group 14	16/06/2026	Approved by		
Injection Moulding Tolerances: ±0.2 mm		Document type	Document status			
		Title Bill of Materials	DWG No.			
			Rev.	Date of issue		Sheet 1/1

Appendix

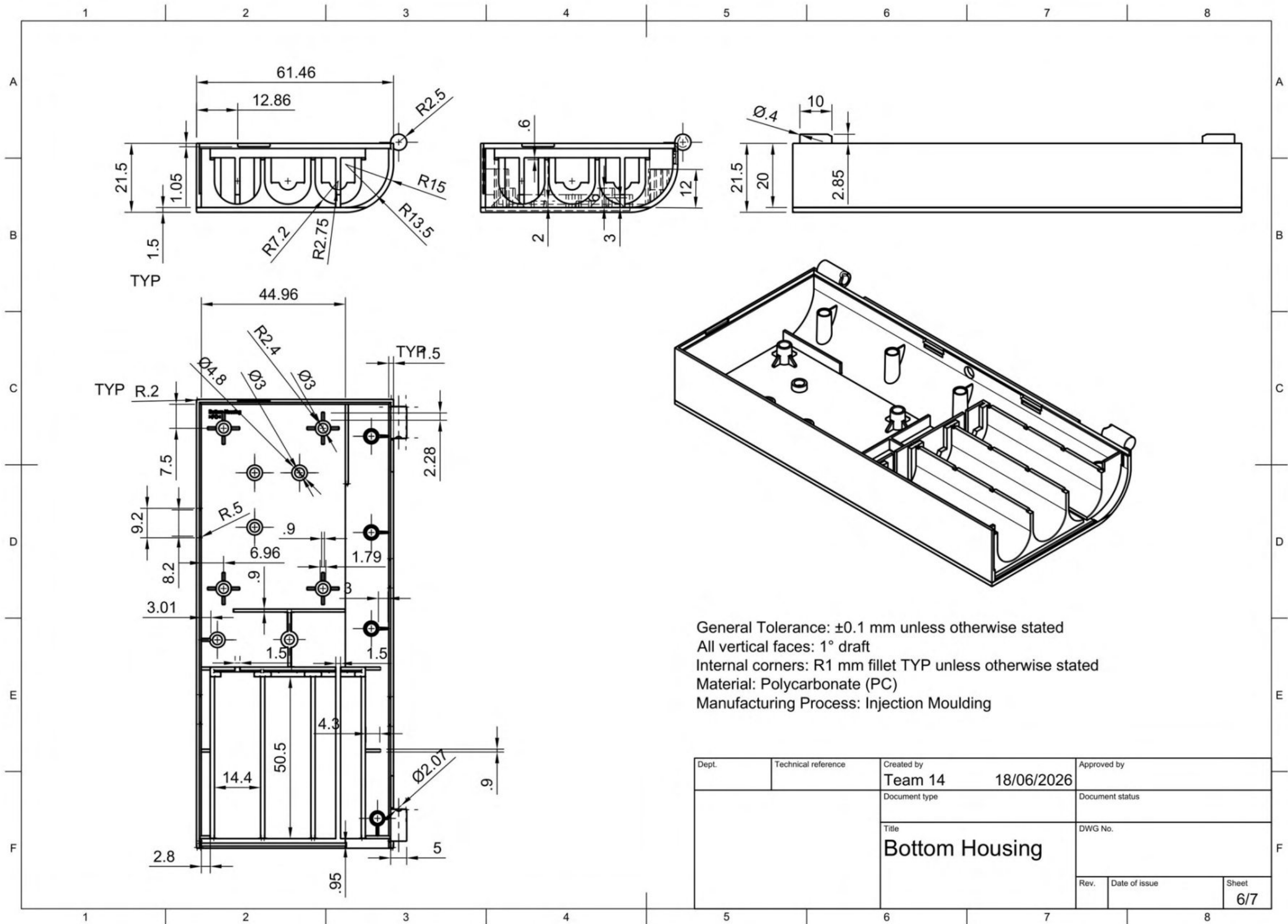


General Tolerance: ± 0.1 mm unless otherwise stated
All vertical faces: 1° draft
Internal corners: R1 mm fillet TYP unless otherwise stated
Material: Polycarbonate (PC)
Manufacturing Process: Injection Moulding

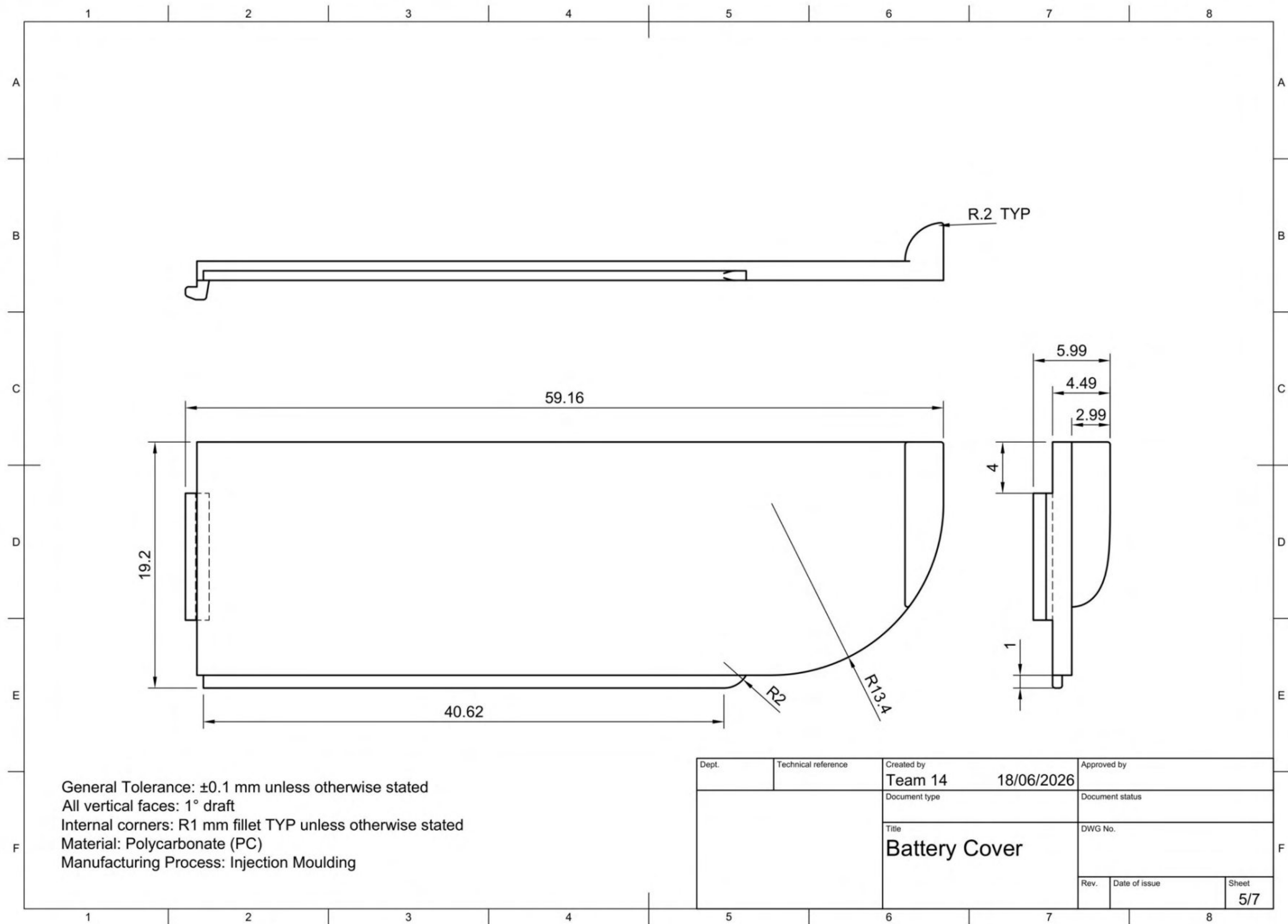


Dept.	Technical reference	Created by Team 14	18/06/2026	Approved by
		Document type		Document status
		Title final poo		DWG No.
		Rev.	Date of issue	Sheet 7/7

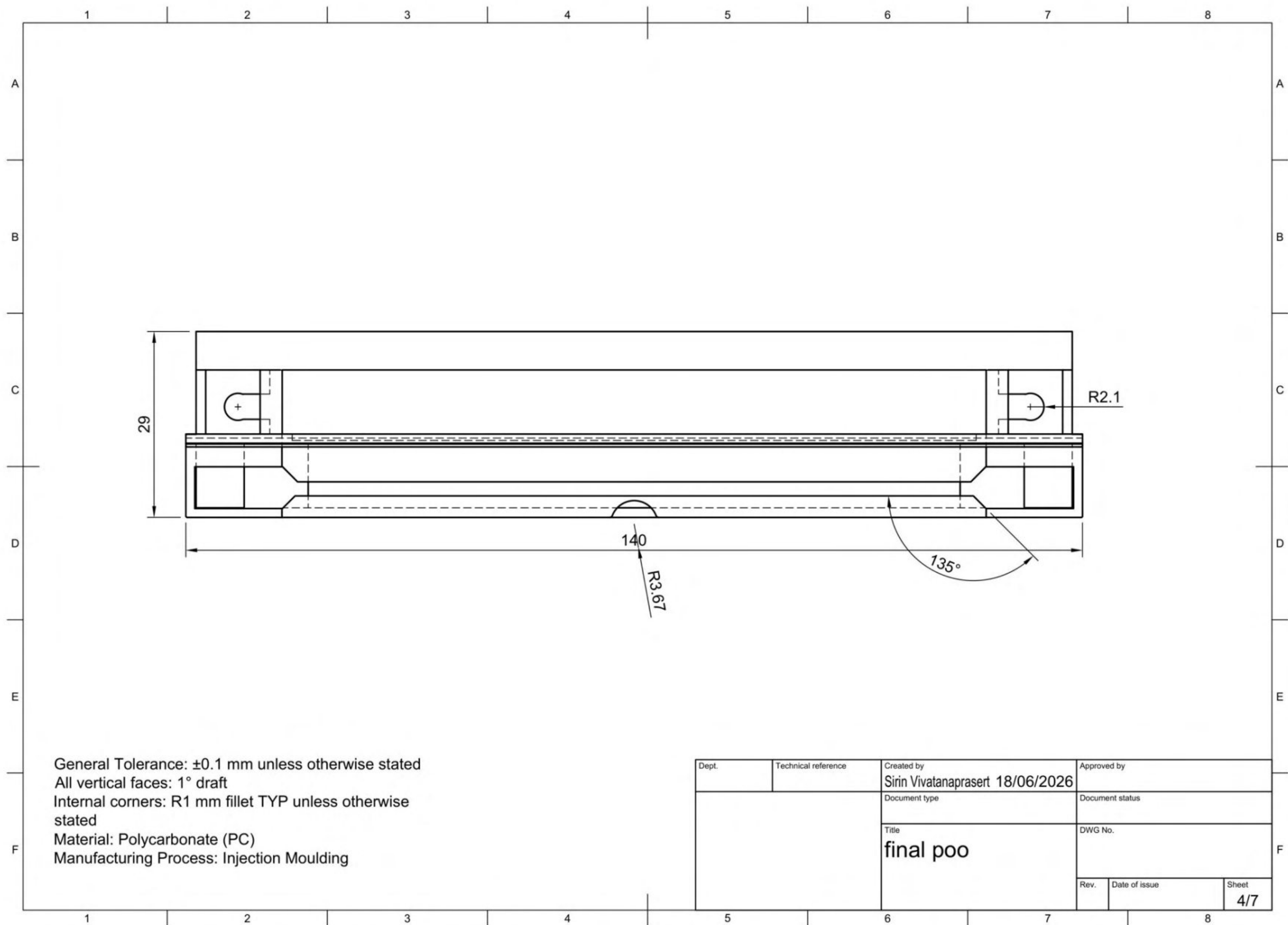
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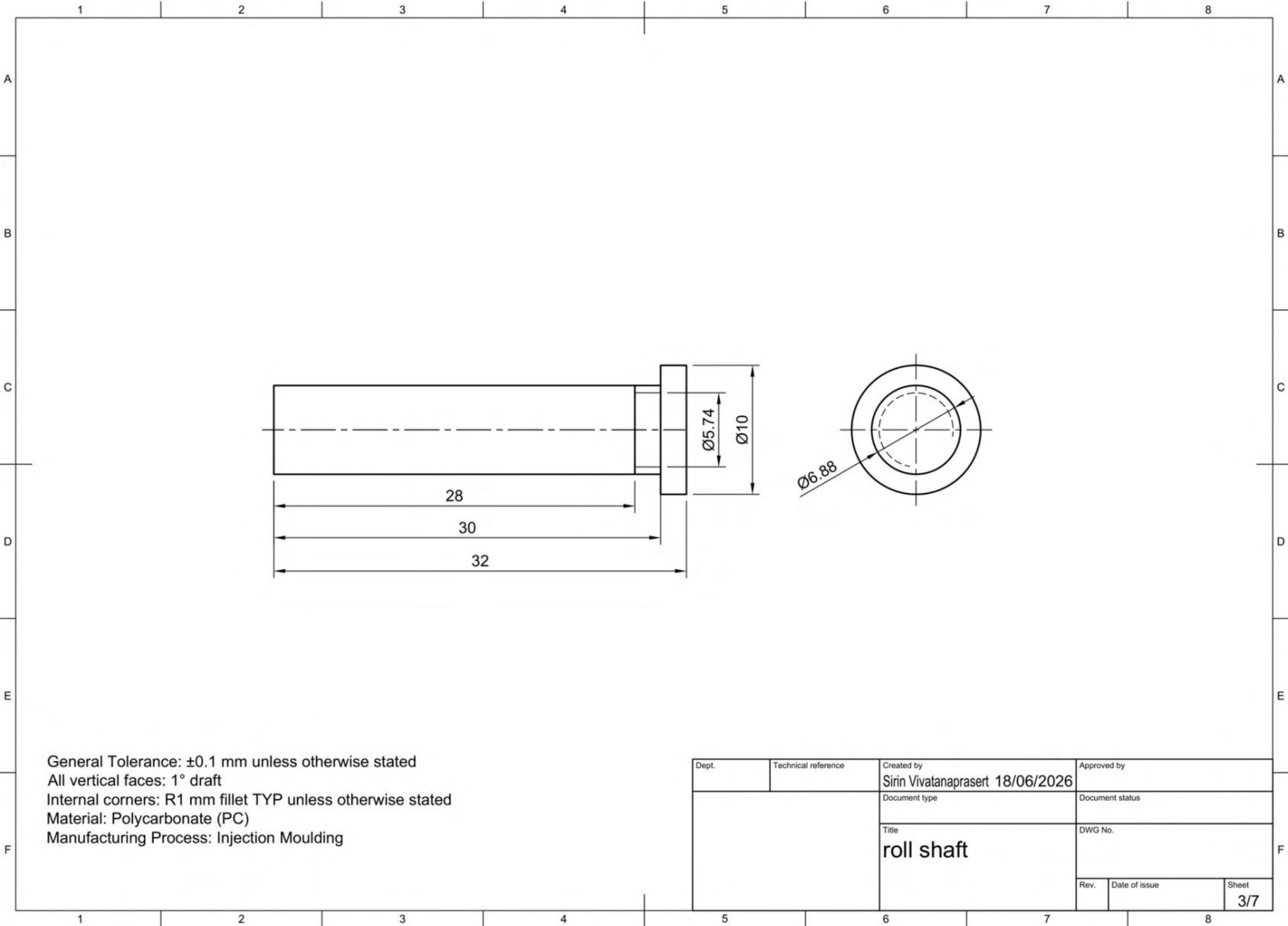
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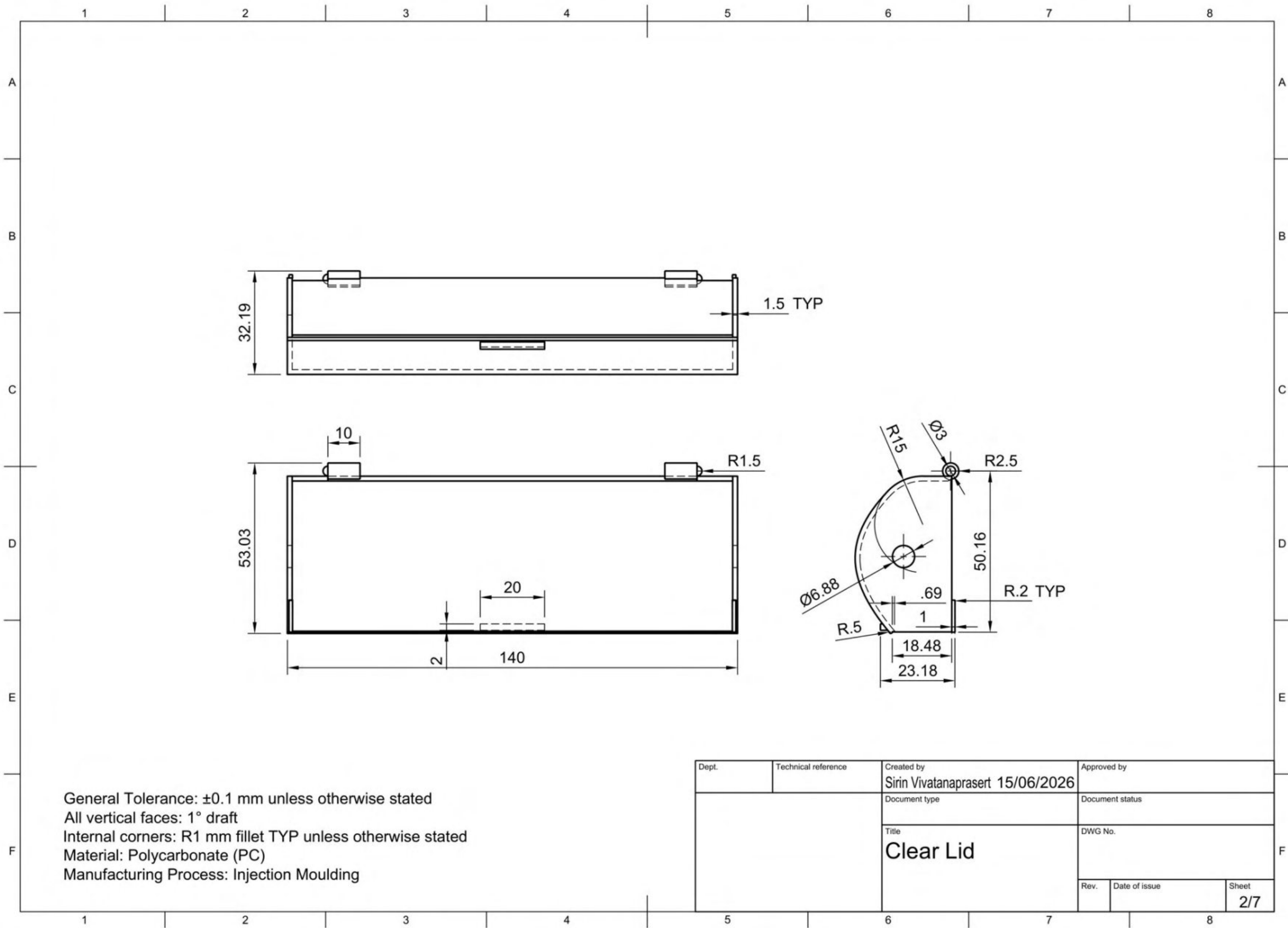
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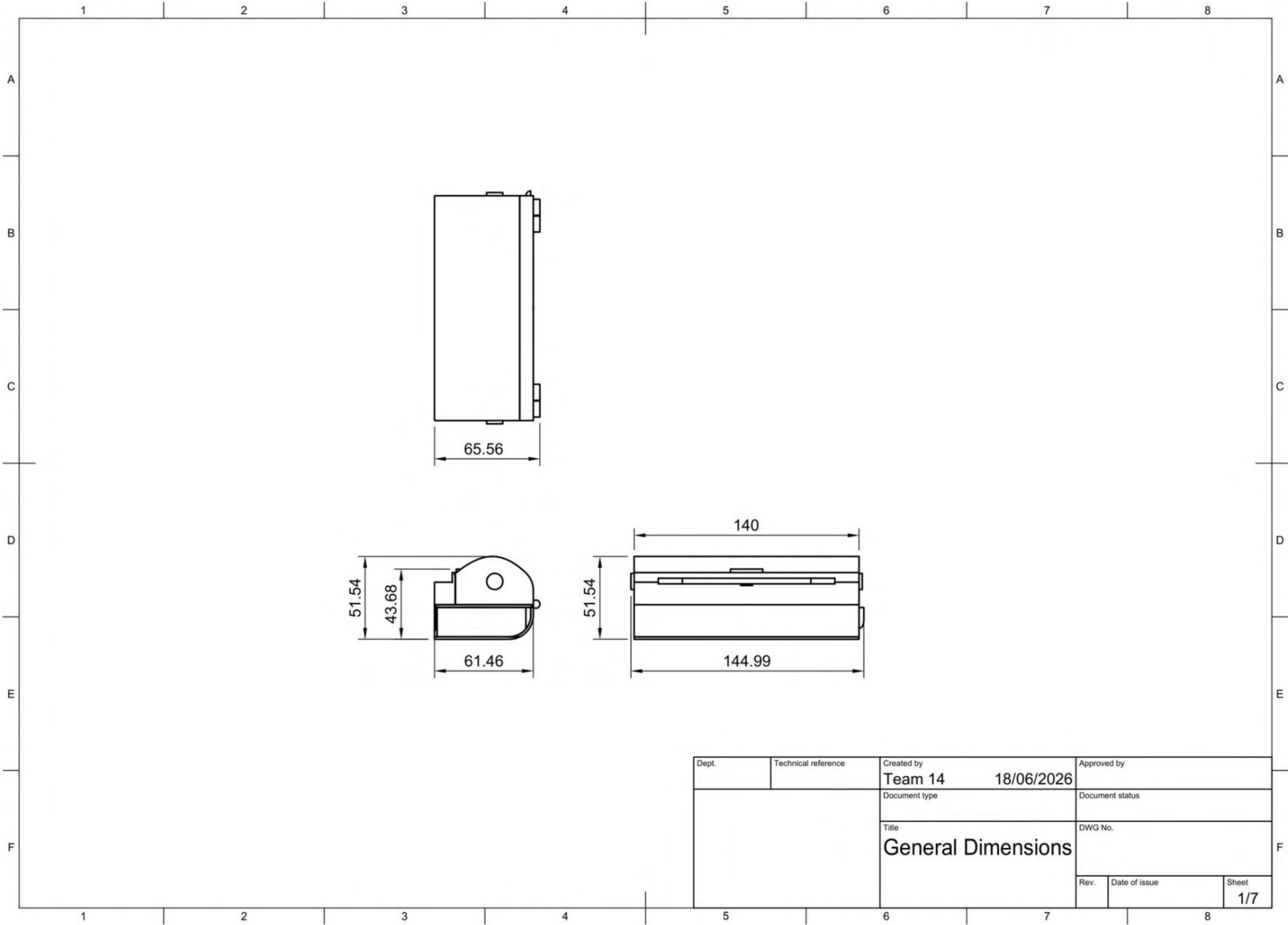
Appendix



Appendix



Appendix



DOOTI's

calling you

Challenging **throwaway culture** through **composting** and material-efficient **dog poop disposal**.



PDE

Dyson School of Design Engineering

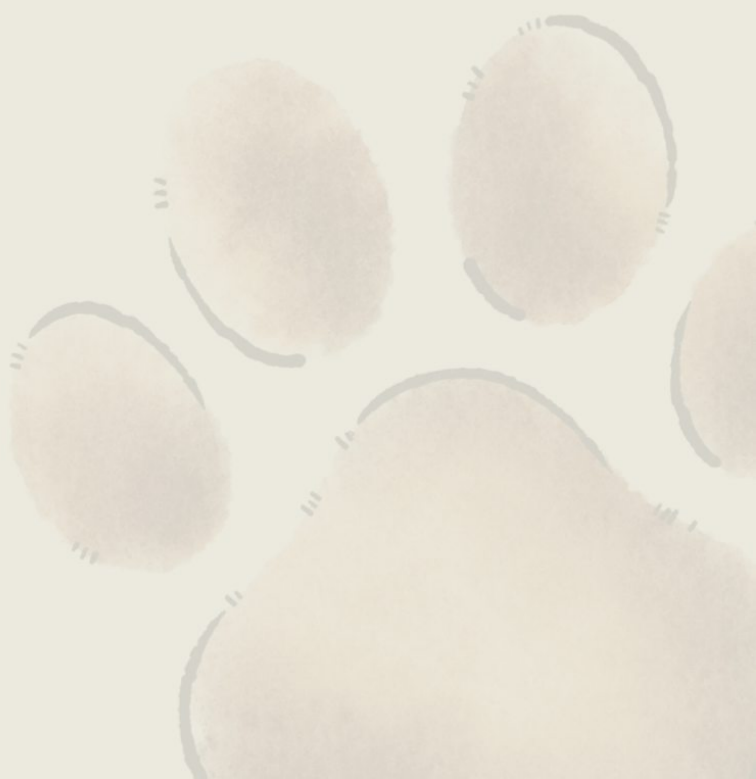
Muk Vivatanaprasert
Yuxuan Zhou
Zhixuan Song
Preme Chaisen

DOOTI's

calling you

2

- **Product Opportunity**
- **Concept Development**
- **Prototyping Journey**
- **Circuit Analysis & Power**
- **Product Details & Analysis**
- **DFMA**
- **Product Compliance**
- **Branding Proposition**
- **Branding Implementation**
- **Product Labelling**
- **Product Packaging**
- **Final Design & Visual Summary**
- **Project Management**
- **Teamwork Management**
- **Appendix**



The Problem

Managing pet waste is an unglamorous and repetitive part of pet care. Proper disposal of dog faeces is widely misunderstood, and with dogs producing waste 1–3 times [1] daily, it accumulates rapidly. One dog generates ~124.1 kg annually [2], roughly equivalent to a baby elephant. Moreover, once this waste is sealed in plastic and sent to landfills, their biological and environmental impacts are rarely considered. **This design project aims to raise awareness of the risks associated with improper pet poo disposal while encouraging and supporting pet owners to adopt more sustainable waste management methods, such as composting and wormeries.**

User Insight

Primary interviews and secondary research demonstrates evident lack of knowledge about the dangers of pet poo which are **mostly ignored for convenience**.

Dog Owner 1

"I drop a pile of them in the woods behind my house with the plants."

- **Raw** dog poo **cannot be used as natural fertiliser** [3], as it may contain harmful pathogens and parasites that contaminate soil and waterways, damaging plants and infecting wildlife.

Cat Owner 2

"We flush cat poop down the toilet using the flushable bags"

- Anglian Water, the largest water company operating in the UK warns that cat poop can contain parasites called *Toxoplasma gondii* [4], that can survive traditional sewage treatment. Not only can this **harm human health** and **risk marine wild life**, it can also cause **sewage blockage** [5].

Market Insight

There are two popular options in market: conventional plastic bags and biodegradable plastic bags. Although biodegradable bags are often perceived as the more environmentally friendly choice, their overall impact is more complex.

Most biodegradable bags are intended for industrial composting conditions [6], however a large proportion ultimately end up in landfill [7]. This bags can degrade and release untreated waste leading to contamination and the spread of pathogens. Similarly, compostable corn-starch based bags present practical limitations. They often do not decompose efficiently in home composting systems due to insufficient heat and processing conditions. In addition, some industrial composting facilities separate bags from organic waste before treatment, while access to suitable composting infrastructure remains limited for much of the population.

User group Rationale

On critical reflection, 49.3% [8] of pet owners bag their poo and immediately trash it into landfills. The uncomfortable truth is that a **large majority** of pet owners **prioritise convenience** and **do not care** about what happens to their pet's poop after it leaves their vicinity. For these cases, using a durable plastic bag that will preserve the doo for centuries to prevent out-breaks is understandable., (Pg. 13 discusses companies which has recognised this) However, this approach ignores the origin of the problem.

On the other hand, **animal shelters** are actively **promote responsible pet ownership** and animal wellbeing. As an organisation, they are **uniquely positioned** to also **encourage responsible dog waste disposal**. By targeting **fosterers and adopters** and introducing sustainable disposal practises and education at the beginning, we can help **establish responsible disposal habits** from the offset. This specific user group are often highly community-minded and civically conscious, motivated by care, responsibility and positive social impact.

Current Infrastructure

The UK lacks dedicated public composting facilities for dog [9] waste due to safety concerns. However, large parks and green spaces could benefit from community-scale controlled composting systems, particularly for owners without gardens. Despite the UK's estimated 13 million dogs[10], investment in dog waste composting remains limited compared to the US[11]. British outdated legislation like **Dogs (Fouling of Land) Act 1996** focuses on waste collection rather than sustainable disposal, resulting in most dog waste being sent to landfill instead of being repurposed.

HMW encourage and support proper pet faeces disposal like composting

Product Opportunity

Subsequently, there is an opportunity to design an alternative dog poo bag device that predominately uses natural materials like paper that can degrade quickly while acting a source of carbon for composting. Parallely, we also decided to explore how material usage can be reduced case-by-case compared to the market adopted standardised sizing poo bags.

The **main challenge** of this project is designing a solution that feels hygienic, sturdy and reliable enough to challenge the perception that plastic is the safest and easiest option for handling dog waste. To shift behaviour, the alternative must not only perform to the same functional standard as plastic but also psychologically reassure users through tactile strength and leak resistance. Ultimately, the proposed product should integrate into the user's disposal journey while supporting them towards alternative sustainable practises like composting, wormeries or septic tanks.

Original Concept

The **original concept** from submission 1.2 was a heat-press device that transformed scrap paper into water-resistant poo bags using a corn-starch coating and heat-drying process, allowing users to repurpose common household waste into practical, low-cost poo bags at home. This solution was then tested.

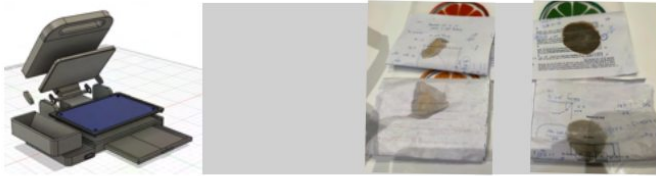


Figure 2.1 shows the treated paper was ~30% more moisture-resistant than untreated paper. However, visible moisture damage and discolouration were considered undesirable by users, while the energy required for drying made the concept more suited to mains power than battery operation.

Redefined Concept

We began by rethinking how to evolve the original concept of creating truly compostable dog poo bags. A key challenge was ensuring the added electronics provided meaningful functionality and user value, rather than feeling unnecessary or gimmicky.

Problem: Concept has to be battery power but this is better suited for portable pet waste devices, where cables could restrict movement, reduce convenience.

Solution: Rather than a home preparation tool, we shifted towards a compact, portable on-demand bag dispenser that seals and cuts variable-sized bags. Designed for walks and everyday use, the device requires minimal energy while offering greater convenience and flexibility for owners.

Value-added: Dog waste varies significantly depending on breed size, yet most poo bags are sold in fixed, standardised sizes. A variable bag-making device would allow users to create only the amount of material needed for each situation, reducing waste and increasing the number of bags produced per roll.

Problem: Paper is not naturally waterproof. Although the corn-starch coating prevented leakage, moisture could still permeate the material, negatively affecting user perception and comfort, as handling dog waste should feel as hygienic and discreet as possible.

Solution: A combination of paper and cellulose film was used. The paper acts as the waste picker and provides an initial moisture and visual barrier, while the cellulose film forms a water resistant, heat-sealable bag that contains the paper and waste after collection. This solution was chosen over bioplastics because both materials are plant-based and suitable for home composting, allowing the entire product to biodegrade naturally after disposal without having to rely on specific industrial setups.

Conceptual Feedback

During **GERF**, we presented the concept of Dooti, a portable, on-demand bag-making device capable of producing compostable poop bags in variable sizes, optimising material usage.

Many attendees resonated with the educational aspects of the project, with several requesting to photograph the Turd Chart. Conversations revealed a significant lack of awareness surrounding responsible pet waste disposal. Of the approximately 50 attendees spoken to, only two reported composting dog waste.

Several discussions highlighted common misconceptions. For example, one participant described disposing of dog faeces by flinging it into their garden using disposable chopsticks. Another used biodegradable bags but still sent them to landfill, unaware that this largely negates their intended environmental benefit.

Problem: One key challenge identified was encouraging users to carry collected dog waste home rather than disposing of it in public bins during walks. User feedback indicated that odour is the primary barrier, alongside a reluctance to carry waste in close proximity to personal belongings. This highlighted the need for a solution that can effectively contain smells while reducing the perceived unpleasantness of transporting dog waste.

Improvement: This feedback prompted a fundamental reconsideration of the user journey. Rather than focusing solely on bag production, we explored a range of odour-proof pouch concepts (Portfolio Pg. 2) designed to allow users to carry multiple used poop bags comfortably and discreetly throughout a walk. Prototype concepts prioritised lightweight construction, compactness, ease of cleaning, and secure storage.

Ergonomics & Inclusion



When developing our conceptual sketches, we explored a range of grip positions and outer case geometries based on different handling orientations. When developing our conceptual sketches, we initially explored integrated finger grips to improve handling comfort. However, user testing showed that the difference between grip designs was not significant, as most participants naturally held the device horizontally regardless of the finger grip detail. Since integrated finger grips would also increase mould complexity and make injection moulding more difficult, the final outer case was simplified into a smoother geometry for easier manufacturing.

To consider inclusion, the product form was designed to support simple one-handed use, allowing users to hold the device steady while sliding it across the bag.

The flat base helps keep the material aligned during cutting and sealing.

The top cover provides enough space for the user to press down comfortably. This reduces hand effort and improves control during operation.

Key Design Criteria

- Must provide an effective visual and odour barrier from the point of waste collection until disposal or composting.
- Must accommodate varying poo sizes and consistencies by making bag sizes variable
- Must be portable, lightweight, and easily attachable to bags, belts, or leads during outdoor use.
- Must improve the convenience and user experience of composting dog waste, reducing the perceived awkwardness and unpleasantness associated with handling and transporting waste.

Requirements & Specifications

Mechanical

1. The device must be compact and portable for outdoor use, with a **maximum mass of 230g**.
2. Every paper-cellulose bag refill has a **width of 120mm**, and a **length of 3.5m** which is estimated to last 20 picks
3. The device must withstand accidental drops during normal use, with an **impact resistance of at least 200 J/m** or equivalent resistance to a 1m drop onto a hard surface.
4. The enclosure material must remain dimensionally stable during operation, with a **heat deflection temperature exceeding 75°C**.
5. Refill cartridges and batteries must be easy to replace, with a **replacement time of less than 1 minute**.

Electrical

1. The heating system must operate safely, incorporating a **thermal cut-off temperature of 75°C**.
2. The device must provide a **minimum operating time of 3 hours under full load**.
3. The battery must achieve a service life of **at least 987 sealing cycles**.
4. Device must show **clear indication when it is being heated** and when it has overheated

Performance

1. The device must provide effective waste containment through a **fully sealed bag with minimal odour transfer** and no direct contact with waste.
2. The device must accommodate varying waste volumes through a **user-adjustable bag length**.
3. The device must produce and seal bags on demand in **20 seconds or less**. (verify through user testing)
4. The bag material must **fully compost in a home composting environment within 3 months**.
5. The bag storage pouch must remain **free from contamination** during normal operation and must be able to be rinsed with water.

Branding and User Experience

1. The product must promote responsible pet waste disposal through a positive and environmentally conscious brand identity.
2. The product must maintain discretion during use by providing a **complete visual barrier to contained waste**.
3. The device must support **one-handed operation** throughout the bag making process.

Product Study



We studied a low-cost portable 2-in-1 bag sealer and cutter as a reference for our heat-sealing design.

Feature 1: Press-to-Heat Mechanism

The sealing process requires pressure to ensure proper heat transfer.

Insights: Narrow gap

The roll outlet will be designed with a narrow gap, allowing the bag to stay in close contact with the heating strip during sealing. By guiding the material through a controlled path, the gap helps maintain consistent pressure and alignment throughout the sealing process.

Feature 2: Unstable Cutting Blade

The blade does not help guide cutting direction so it is difficult to cut in a straight line.

Insights: Direction Secured Blade

We will use a direction-secured blade to control the cutting path more accurately. A guided mechanism will help keep the blade aligned during operation, reducing unwanted movement and improving cutting precision.

Feature 3: Insecure Heating

The heating strip heats continuously when pressure is applied, which may cause overheating or damage to nearby components.

Insights: Timed Heating System

We will use a timed heating system, activating the strip for only 2 seconds per trigger to improve safety. By controlling the heating duration more precisely, the system can reduce overheating risk, and improve energy efficiency.

Portability (Hook)



Portability was a key requirement, as users preferred not to carry separate bags while walking their dogs. To address this, a hook system was integrated into the design, allowing the device to be conveniently attached to the user.

The hook is connected via a cord, enabling the product to hang securely from a bag, belt, or belt loop. This keeps the device readily accessible during walks while allowing users to dispense a bag quickly and easily with one hand when needed.

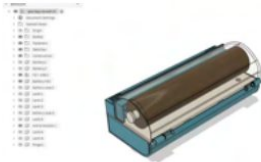
Structure & CAD Model

CAD models were created in Fusion 360 and 3D printed throughout the project to develop usable looks-like prototypes and refine the product form.



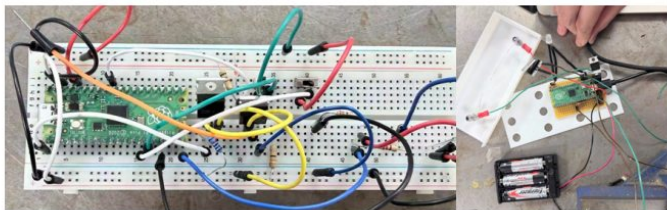
Initial version: The initial product structure was developed in Fusion 360. The first version is aimed to show the general shape and structure for the product.

Iterated version: Shows accurate dimensions and connections between joints and shows the progress for DFA. Certain features including cutting, replacing material and rolling column is introduced in both versions. Different model for the shape of the shell were designed for further selection and optimisation.



Final version: Shows accurate dimensions and connections between joints and shows the progress for DFA. Certain features including cutting, replacing material and rolling column is introduced in both versions. Different model for the shape of the shell were designed for further selection and optimisation.

Electronics & Coding



Controller Selection: The Pico board was selected as the device controller because it is compact, low-cost, and has enough GPIO pins for the switches, RGB LED, and heating control. Its ADC input also allows thermistor-based temperature monitoring, enabling timed heating and automatic overheat cut-off.

Electronics Development: The electronics system was developed through an iterative prototyping process, moving from breadboard testing to a more compact stripboard prototype, and finally to a custom PCB for reliable integration into the final product.

Code: Controls switch detection, heating control, temperature monitoring and LED feedback.

- **Raspberry Pi Pico:** Triggers the heating strip for a short 2-second cycle when the correct switch condition is detected.
- **Thermistor:** Continuously checks the temperature to prevent overheating. The RGB LED provides clear system feedback.

GERF: User-feedback



User feedback showed that the home-composting concept was generally well received, as it addresses a real but often overlooked problem.

Shape & Direction: We developed three different cover shapes and two bag-pulling directions to understand user preferences.

Education & Advertising: Visual illustrations of the refined final model were combined with educational information about poop-colour meanings to attract users and make the product more engaging.

Poop Picking Challenge: Edible brownies were shaped like poop to let users test different picking-up methods in a playful way. Participants found the activity engaging and provided useful feedback on handling methods, difficulties, and complaints.

Improvements

- **Cleaner waste collection:** The two layers are used separately. The paper is used to pick the waste while the sealed film is the container.
- **Easier carrying for composting:** A pouch was designed to reduce the discomfort of carrying used bags home, making users more willing to compost the waste themselves.

Branding & Packaging

Branding

The branding strategy was developed around a playful and educational identity called DOOTI, using humorous dog-poo illustrations and a friendly tone to make responsible pet waste disposal feel less awkward and more approachable. Inspired by Battersea Dogs & Cats Home's warm visual style and public education role, the brand aims to raise awareness of composting while keeping the message simple, memorable and emotionally engaging.

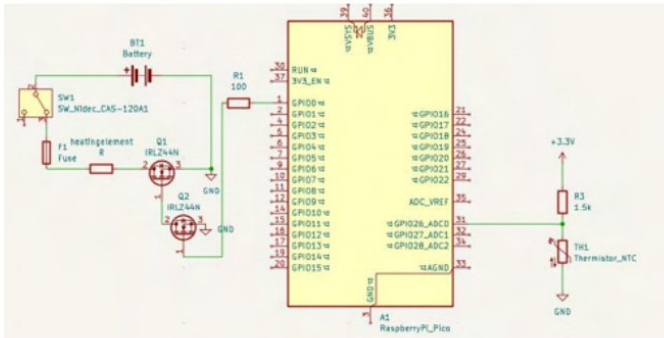
Packaging

The packaging was designed as a low-cost, recyclable and easy-to-separate system, using a removable paper sleeve, cardboard box and cardboard frame instead of plastic or complex mixed materials. It protects the product during transport, communicates key user-guide and disposal information clearly, and supports end-of-life recycling with clear labels and minimal adhesive use.

Product Validation

Beyond the technical testing of Dooti's portable bag maker, we conducted an accelerated compostability assessment of the bag materials and a collection performance test to evaluate the bag's effectiveness in handling dog waste of varying sizes, shapes, and moisture levels. These tests helped validate both the environmental claims of the material and the practical usability of the system in real-world conditions.

The Circuit



Component List

- **Raspberry Pi Pico:** Acts as the control unit, reading the thermistor and limit switch inputs, then controlling the MOSFET to turn the heating element on or off.
- **Thermistor (MF58 10k B3950 NTC):** Measures the temperature near the heating element so the system can stop heating if it becomes too hot.
- **1.5 kΩ fixed resistor:** Forms a potential divider with the thermistor, allowing the Pico to read temperature changes as voltage changes.
- **MOSFET:** Works as an electronic switch that allows the Pico to control the higher-current heating element safely.
- **Heating 26AWG nichrome wire:** Produces heat to seal or cut the material when activated.
- **Micro switches:** Detect when the cutter reaches the end of its movement and trigger a timed heating cycle.
- **RGB LED:** Provides visual feedback, showing green during heating and red when overheating or sensor error occurs.

Power Calculation

$$P_{sum} = P_{he} + P_{pd} + P_{pico} + P_{mosfet}$$

$$P = \frac{V^2}{R}$$

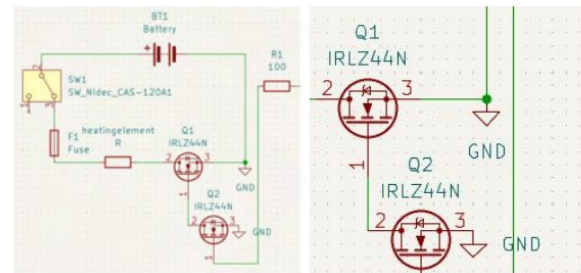
$$P_{sum} = \frac{7.4^2}{5} + \frac{3.3^2}{3000} + 3.3 \times 0.35 + 2 \times \frac{3.3^2}{10000} = 12.11W$$

Heating element is the dominant power load in the circuit, consuming around 11 W, while the Pico board, thermistor potential divider, and MOSFET control circuit use only a very small amount of power.

This means the battery life and energy efficiency are mainly determined by how long the heating element is switched on.

By limiting each heating cycle to 2–3 seconds, the design reduces unnecessary energy consumption, helps prevent overheating, and makes the device safer for repeated short heating operations.

Darlington Pair of Mosfet



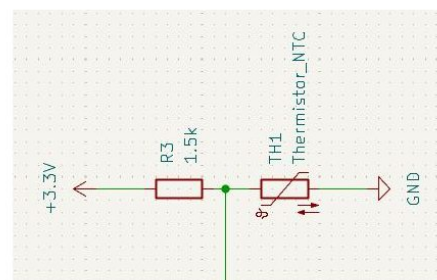
Why Darlington Pair

The Darlington MOSFET pair is used because the Pico's 3.3V GPIO signal is not enough to reliably drive the main MOSFET heater switching stage directly. The first MOSFET acts as a control stage, using a pull-up resistor to drive the second MOSFET's gate more reliably. The second MOSFET then switches the higher-current heating circuit. The MOSFET occupied 0.00363W, which is a small portion of the overall power.

Reversed Logic

The Darlington MOSFET logic is reversed because the first MOSFET works as an inverter. When the Pico GPIO outputs HIGH, the first MOSFET turns on and pulls the second MOSFET's gate down to GND, so the second MOSFET turns off and the heater is off. When the Pico GPIO outputs LOW, the first MOSFET turns off, so the 10 kΩ pull-up resistor pulls the second MOSFET's gate up to 3.3 V, turning the heater on. Therefore, in this circuit, GPIO LOW = heater ON and GPIO HIGH = heater OFF.

Potential Divider



Because the heater is the dominant load and can overheat, the circuit includes multiple safety layers: the thermistor monitors temperature, the Pico cuts power through the MOSFET, the timer limits heating duration, the fuse protects against overcurrent, and the manual switch allows physical disconnection of the heater power.

The maximum temperature of the device is set to be 75 degree Celsius to avoid safety concerns. A potential divider is set up as safety insurance to monitor the temperature and cut off the whole circuit if necessary.

The thermistor has a 10k ohm resistance under room temperature and 1.5k at 75 degree. To ensure accuracy and sensitivity, a 1.5k resistor is picked in the potential divider as it has to be sensitive at 75 degree temperature.

Compostable Bag

The compostable bag was designed with two layers, consisting of an inner NatureFlex cellulose film layer and an outer paper layer. Only the film is sealable.

Paper is about £0.08/m², while NatureFlex cellulose film is estimated at £0.84/m²; a 3.5 m refill roll costs roughly £1 in material.

Why paper:

- Paper is biodegradable and fits better with the composting-based disposal concept than conventional PE plastic.
- Paper is relatively low-cost and lightweight.

Why natureflex cellulose film:

- NatureFlex cellulose film was chosen as the inner layer because it provides a compostable barrier instead of using conventional PE plastic.
- Helps reduce moisture leakage from wet pet waste.
- As a cellulose-based material, NatureFlex better matches the composting-based purpose of the product.

Why not PE:

- Although PE is cheap, flexible, and waterproof, it can remain in the environment for a long time after disposal.
- If PE bags are used to collect pet waste, the waste is usually sealed inside plastic and sent to landfill, making composting difficult.

Casing

The casing mainly consists of a base for holding the electronics, a narrow slot for heat sealing, a transparent cover and a rotatable roll holder.

- The transparent rotatable lid allows users to see the remaining bag roll, making it easier to notice when a refill is needed.
- The roll holder allows free rotation of the bag sheet roll
- The heating sealing slot is made narrow to allow sealing

Heat Sealing

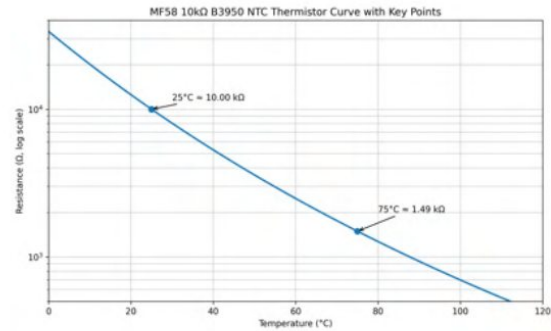
Why we use heat sealing?

This method was selected because it creates a cleaner and more secure closure than simply folding the bag. It helps reduce leakage, smell, and direct contact with pet waste during disposal.

Why not other methods:

- **Adhesive:** Adhesive was not selected because it could reduce composability, add extra material complexity, and may fail when exposed to moisture from pet waste.
- **Clips or staples:** Mechanical closures such as clips or staples would add non-compostable components and make the disposal process less convenient. Heat sealing keeps the closure integrated into the bag itself.

Heat Safety



Heat safety was considered as a key requirement because the product uses a heating strip to seal the material.

How to reduce risk:

- **Time Control:** To reduce the risk of overheating, the heating process is only triggered for a short 2-second cycle instead of heating continuously.
- **Thermistor:** A thermistor is used to monitor the temperature near the heating element, allowing the system to cut off power if the temperature becomes too high.
- **Circuit Control:** The heating strip is also controlled through the electronic circuit rather than directly by the user, helping to prevent accidental continuous heating.

Code Explanation

```
float tempC = tempK - 273.15;

// When temperature reaches 70C, start 3-second heating timer
if (tempC >= heatingStartTemp && !timerStarted) {
    timerStarted = true;
    heatTimerStart = millis();
    Serial.println("Temperature reached 70C. 3-second heating timer started.");
}

// If temperature reaches 75C, turn off immediately
if (tempC >= absoluteCutoffTemp) {
    heaterOn = false;
    Serial.println("Safety cutoff: temperature reached 75C. Heater OFF.");
}

// If 3 seconds have passed after reaching 70C, turn off heater
if (timerStarted && millis() - heatTimerStart >= maxHeatTime) {
    heaterOn = false;
    Serial.println("Maximum heating time reached. Heater OFF.");
}

digitalWrite(heaterLED, heaterOn ? HIGH : LOW);
```

This code uses two limit switches to control when the cutter should heat. The left and right switches are connected to separate Pico GPIO inputs with internal pull-up resistors, so each switch reads HIGH when released and LOW when pressed. Heating is only triggered when one switch is newly pressed while the other switch is released, which prevents accidental heating when both switches are pressed or when one switch is held down continuously. When a valid switch trigger is detected, the Pico turns on the MOSFET for 2 seconds to heat the cutting wire, then automatically turns it off. At the same time, the thermistor monitors the temperature through the voltage divider; if the temperature reaches 75 degree Celsius, the heater is immediately turned off and locked for protection. The RGB LED shows the device status: green during heating, red during overheat or sensor error, and off when idle.

Issue 1: Reversed MOSFET logic

A key challenge was that the Darlington MOSFET pair made the heater logic reversed. Instead of GPIO HIGH = heater ON, the circuit worked as GPIO LOW = heater ON and GPIO HIGH = heater OFF.

How we solved this:

We solved this by adding `const bool OUTPUT_ACTIVE_HIGH = false;` and creating a separate `setHeater()` function. This function handles the reversed logic internally, so in the rest of the code we can simply write `setHeater(true)` to turn heating on and `setHeater(false)` to turn it off.

Issue 2: Avoiding repeated heating

A challenge in the switch control logic was that if the program only checked whether a switch was currently pressed, the heater could be triggered again and again while the user was still holding the switch down.

How we solved this:

We solved this by detecting a new press event instead of just detecting a pressed state. In the code, the previous switch state is stored using `lastLeftSwitchState` and `lastRightSwitchState`, and a new press is only detected when the switch changes from HIGH to LOW. For example, `leftNewPress = lastLeftSwitchState == HIGH && leftSwitchState == LOW` means the left switch has just been pressed, not simply held down. After each loop, the code updates the previous switch states, so the heater will not retrigger until the switch is released and pressed again.

Cutting Mechanism

The improved cutting mechanism uses a direction-secured blade that moves along a fixed path. This keeps the blade aligned during use, allowing the material to be cut in a cleaner and more controlled way. The guided structure also reduces unwanted sideways movement, improving cutting accuracy and making the product safer and easier to operate.



Blade Design

- The blade component was designed to support a smooth pull-and-cut action.
- The cutting edge is positioned inside the lower opening, so the blade is not directly exposed to the user.
- This improves safety while still allowing the bag sheet to be cut when it is pulled through the slot.

Ring Feature

- The raised ring gives users a clear area to hold and pull.
- It makes the interaction more intuitive, as users can naturally grip the ring and pull the bag sheet forward.
- This helps improve control during the pulling, cutting, and sealing process.

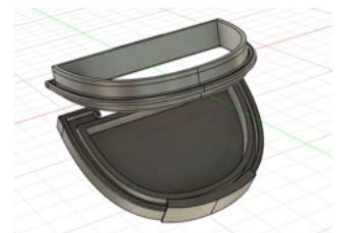
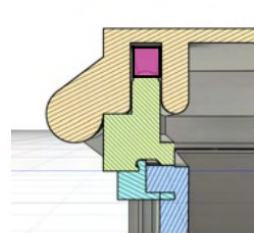
Refill Rolls

The refill roll can be manufactured using a continuous roll-to-roll tube converting process. A cellulose film web is heat sealed into a tubular sleeve, while a paper web is simultaneously formed and glued into a separate sleeve. The cellulose sleeve is then inserted into the paper sleeve, compressed through nip rollers to remove trapped air, and wound onto a cardboard core. This process maintains separation between the paper and cellulose layers while enabling high-volume production.



Odour-Proof Pouch

To ensure effective odour containment, the pouch was designed with the requirement of achieving an airtight seal. Inspired by the sealing mechanism used in LocknLock food containers, the design incorporates a silicone gasket that compresses when the lid is closed. This compression creates a tight seal that minimises the passage of air and odour molecules, helping to keep stored waste contained until it can be disposed of appropriately.



Material Rationale: Silicon

Silicone rubber with a Shore A hardness of 30 was selected for the pouch due to its flexibility, durability, and resistance to moisture and contamination. The material provides sufficient stiffness to maintain its shape and support the collected waste while remaining flexible enough for cleaning and repeated use. Silicone was also chosen for its chemical resistance and ease of washing, making it suitable for an outdoor pet-waste application. During prototyping, a softer Shore A hardness of 20 was used to improve demoulding ease by allowing higher material flexibility.



Injection Moulding

The main product casing and plastic components was developed for **injection moulding** using DFMA principles in accordance with ISO8887. Key design considerations are discussed below.

Wall thickness & Strength

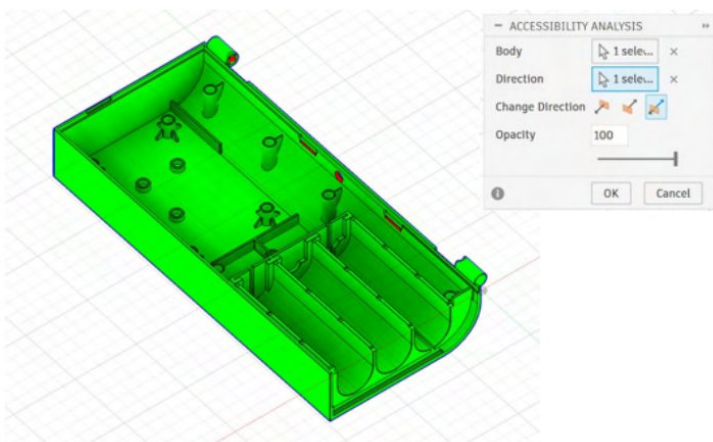
The enclosure uses a nominal wall thickness of 1.5 mm to balance strength, material usage, and cooling time. Structural stiffness is provided through ribs with a thickness of 0.9 mm (60% of the nominal wall thickness), following recommended injection moulding guidelines to minimize sink marks while maintaining rigidity. Additional ribs are concentrated around the battery compartment, where the highest loads are expected, providing increased local reinforcement without significantly increasing material usage.

Mould release

All vertical surfaces include a minimum 1° draft angle to facilitate mould release.

Fillets and chamfers ranging from 0.2–2 mm are incorporated to reduce stress concentrations and improve mould filling. Larger fillets are used for mating parts and snap fits. These fillets improve mechanical durability while reducing the likelihood of crack initiation during repeated use.

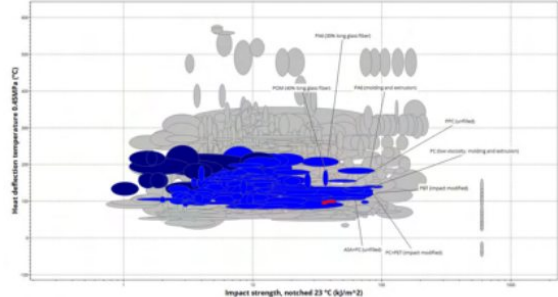
Undercuts were minimized throughout the design and assessed using Fusion 360 accessibility analysis based on the intended mould pull direction. Most features are designed to allow release from a simple two-part mould. However, unavoidable undercuts remain within the snap-fit recesses, hinge mechanism, and front blade housing due to functional requirements. The front blade housing contains the most significant undercut and would be a key area for future redesign to reduce tooling complexity and manufacturing cost.



Ejector pins are positioned on non cosmetic internal surfaces. The pins are evenly distributed across the part to provide uniform ejection forces, reducing the risk of warping, distortion, or damage during mould release.

Material Selection

Level 3 Eco-design database in Ansys Granta EduPack was used to support the casing material selection. **PC (low viscosity, moulding and extrusion, £2.23–2.56 per kg)** was selected for its heat-resistant, insulating, affordable, and manufacturable for a heat-sealing tool casing.



Key Selection Criteria

- **Heat Deflection Temperature 0.45 MPa (Y-axis):** Used to assess deformation under light load and heat. The range was limited to 90–200°C to stay safely above the 75°C cut-off without selecting overly expensive high-performance materials.
- **Impact Strength notched 23°C (X-axis):** Used to assess resistance to drops and sudden impacts. A moderate-to-high value was preferred for durability while maintaining low cost.
- **Other Limitations:** Selection was limited to polymers only, with price ≤ 3 GBP/kg, acceptable or excellent injection moulding, thermal conductivity ≤ 0.5 W/m·K, and maximum service temperature $\geq 90^\circ\text{C}$ to ensure a lightweight, low-cost, manufacturable, insulating, and thermally safe casing.

Why not PA6 or PPC:

PA6 has high heat resistance, but this is unnecessary because the casing only needs to remain stable above the 75°C circuit cut-off temperature. PA6 also absorbs moisture, which may affect dimensional stability and is less ideal for a handheld casing. PPC was not selected because its lower impact strength makes it less suitable for a product that may be dropped or hit during daily use.

Why PC:

Polycarbonate (PC) was selected for its high impact resistance, UV resistance, and thermal stability. Its heat deflection temperature is well above the system's 75°C thermal cut-off temperature, ensuring dimensional stability during use. PC is also well suited to injection moulding and is available in transparent grades, allowing a clear lid to be incorporated so users can view the remaining bag roll without compromising enclosure durability.

For prototyping, 3D-printed PLA was used. Although PLA has lower toughness and different material properties than the intended injection moulded PC enclosure, testing confirmed that key features, including the snap-fits, alignment features, and enclosure assembly, functioned as intended. Mica insulation plates were incorporated around the heating element during testing to prevent warping of the PLA components.

Alignment features

Bosses are incorporated to align mating parts, mount the PCB, and provide structural support. To minimize sink marks, bosses are positioned at least 3 mm from external walls and reinforced with ribs and gussets where necessary. Alignment bosses are paired with locating pins on the mating enclosure part, providing accurate positioning during assembly. These pins are also reinforced with gussets to improve strength and prevent damage during assembly and disassembly. Additional support bosses are also added beneath the Raspberry Pi Pico help prevent PCB flexing and maintain clearance between solder joints and the enclosure floor.

The enclosure lip and perimeter locating tabs provide self-aligning features that guide the mating halves into the correct position during assembly. This improves assembly accuracy, reduces assembly time, and helps maintain a consistent seal between the enclosure halves.

Electronics Integration

Electronics Integration

Integrated guide rails and support bosses locate and secure the PCB while maintaining clearance for solder joints. Dedicated wire-routing features improve cable management and reduce assembly errors. A switch is incorporated into the power circuit, allowing the battery to be isolated during maintenance and reducing the risk of accidental activation of the nichrome heating element.

Fastening Strategy

The primary enclosure assembly uses cantilever snap fit features to reduce part count, assembly time, and the need for additional hardware. The lid hinge is assembled using integrated snap fit features, eliminating the need for separate hinge components. Where threaded fasteners are required for securing the PCB and blade housing, a single standard fastening system consisting of M4 bolts, nuts, and washers is used, simplifying assembly and maintenance.

Serviceability and EOL

The product is designed for repairability, allowing all major components, including the battery, blade, heating element, electronics, and enclosure parts, to be individually removed and replaced. This extends product lifespan by enabling repair of failed components rather than replacement of the entire product. The modular design also supports end-of-life recycling by allowing plastic and electronic components to be easily separated for material recovery. To further aid recycling, enclosure components are marked with the material identification code >PC< for easy material identification and sorting. A dedicated side access battery compartment enables routine battery replacement by the user without exposing the inner circuit.

Assembly process

1. Install the battery contacts into the battery compartment and battery replacement lid.
2. Mount the PCB onto the bottom housing and secure using four M4 screws.
3. Assemble the blade housing to the floor using two M4 bolts, washers and nyloc nuts, while securing the nichrome wire, thermistor and ring terminal connections.
4. Install the blade, microswitches and LED into the floor/blade housing assembly and route wiring through the designated openings.
5. Connect all electrical components to the PCB using dedicated headers.
6. Align and snap-fit the floor/blade housing assembly into the bottom compartment.
7. Attach the hinged lid and install the roll shafts and bag roll.
8. Insert batteries and perform a functional test of the device.

Optional Pouch Add On

The silicone pouch would be manufactured using liquid silicone rubber (LSR) injection moulding. The component was divided into two mating halves to simplify moulding and assembly, while a uniform wall thickness of 1.5 mm was selected to minimise material consumption and production cost. A minimum 2° draft angle was applied to all vertical faces in the mould pull direction to facilitate demoulding and improve manufacturability. Additionally, a minimum of 1.5 mm fillets were incorporated at internal and external corners to reduce stress concentrations, improve material flow during moulding, and eliminate sharp edges.

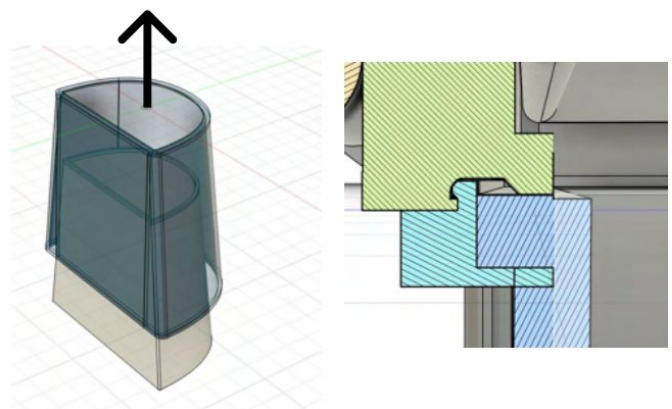
We tested two prototype methods for joining the silicone pouch to the side lid assembly.

1. Stretch-Fit Joint (Permanent)

The pouch opening was manufactured slightly undersized and then stretched over the lid feature to create a secure interference fit. This approach reduced part count and eliminated the need for additional fasteners or adhesives.

2. Compression Flange Joint (Seperable)

The pouch incorporated an overhanging flange that was mechanically captured between two lower lid components. When assembled, the lid pieces compressed the flange, creating a secure retention method while simplifying assembly and disassembly.



GPSR [12]

The General Product Safety compliance (2005) informed the development of safer user interaction, requiring the product to be designed and communicated in a way that ensures they are safe for foreseeable use including mishandling.

Our response: The device was designed to minimise user risk by fully enclosing the cutting mechanism, preventing direct access to moving components during operation. Additionally, the heat-sealing area is shielded to reduce the likelihood of accidental contact or burns during use.

Section 5 states producers must provide clear safety information so consumers can understand potential risks during normal or foreseeable use and take appropriate precautions.

Our response: We acknowledge the inherent risks of composting dog waste. Therefore, the product's user guide transparently outlines contamination risks, safety precautions and responsible composting practices to educate users and support informed disposal decisions.

As the product does not directly interact with or physically handle animals, Animal Welfare Act 2006 [13] was not considered directly applicable, despite the product being positioned within the pet care market.

Electronic Compliance

General Product Safety Regulations [12] and **EMC Regulations 2016 [14]** informed the development of the product's low-voltage electronic system. The main risks include overheating, accidental burns, short circuits and potential electromagnetic interference.

Our response: A **MOSFET** is used to safely switch the higher-current heating circuit on and off, enabling timed heating and automatic cut-off. A **thermistor** monitors the sealing temperature, so the Pico can turn the MOSFET off if overheating is detected. The heated area is physically **shielded** to reduce burn risk, while **short and organised** wiring helps minimise electrical noise and potential electromagnetic interference.

RoHS [15], WEEE [16] and Battery Regulations [17] informed the selection, separation and disposal of the product's electronic components. These regulations consider restricted substances in electrical parts, safe battery handling, battery removal, and correct recycling of electronic waste at the end of the product's life.

Our response: Electronic components, including the Raspberry Pi Pico, wires, switch, MOSFET and LED, are sourced from **RoHS-compliant suppliers**. The **battery** is housed in a removable enclosed compartment with polarity markings to reduce incorrect installation, exposed terminals, short circuits and overheating from misuse. At **end of life**, the battery, wiring and circuit module can be separated for battery and e-waste recycling, with clear labels warning users not to compost or dispose of electronic parts with dog waste, compostable bags or general waste.

Compostability Standards

EN 13432 [18] & **EN 17427 [19]** governs the validity of composting claims for industrial and home-composting respectively, the latter focusing on carrier bags. The main difference being how home temperature conditions () are much lower. As such, this was used to help guide material validation and testing strategy for this project.

Our response: We evaluated the compostability of our prototype bags across different material composition by simulating home-composting conditions. EN 17427:2022 metrics suggest a that the bag material should disintegrate by 90% within six-months under 'well-managed composting conditions.' The methodology and results of the compost validation test is further explained on page 19.

EN 17424 states that a compostable bag does not automatically make the resulting compost safe, which is especially important given the inherent risks associated with composting dog waste.

Our Response: Dooti's packaging and branding emphasise transparent user education by clearly outlining which types of dog waste may be more appropriate for composting and which should be avoided. While the bag material itself is home-compostable, users are encouraged to independently assess the quality and safety of the waste before composting, supporting more informed and responsible disposal behaviours.

Marketing Compliance

The **Digital Markets, Competition and Consumers Act 2024 (DMCCA) [20]** regulates green claims made by producers, preventing unfair commercial practises that can mislead consumers. Although not law, CMA published the Green Code, outlining what was considered unfair [21].

- Be truthful and accurate
- Be clear and unambiguous
- Not omit or hide important relevant information
- Be fair and meaningful
- Consider the full life cycle of the product or service
- Be substantiated

Our Response: We considered how the Green Claims Code would influence our branding, packaging, and communication strategy. Our aim was to balance simplicity with transparency, making key information easy for new users to understand without obscuring important details. The user guide was designed to provide clear, accessible instructions while offering opportunities for users to explore topics in greater depth through additional resources.

To support our environmental claims, we also used Eco Audit during prototype evaluation to assess the impact of Dooti's bag throughout its lifecycle and verify its potential environmental benefits.

Market Context

To better understand how disposal pet product are marketed, we began by looking at the state of the poo bag market where two brands stood out, earthrated and Resealed Bags whom covered different targets of the shared market. [22][24]

To differentiate, earthrated is a brand that specialises in 'compostable' eco-friendly bags to portable bag dispensers than can be hung onto a leash. However in 2024, earthrated faced a **\$845,000 class action settlement claim for false advertising** [23] where Plaintiff and users claims that the bags do not break down in compost and instead into microplastics.



(earthrated denied any wrong doings but agreed to pay the claims).

In contrast, PET IMPACT's **ReSEAcled** Dog poo Bags brand themselves as "**Truely Eco Friendly Sustainable Dog Waste Bags**" [24] due to how their bags are made out of recycled plastics and oyster shell waste. As brand of their market strategy, PET IMPACT acknowledges their past doings as a seller of 'biodegradable bags' but changed their product line after learning that most of their bags ends up in landfill and breaks, spreading contaminants. Unlike Earth Rated, PET IMPACT responds to the real-world behaviours and disposal habits of the majority of pet owners while creating a sense of transparency backed up by academic research.



Critical Reflection

It is crucial that our branding is transparent and honest about the inherent limitations of our product through our labelling and user guide requirement. With the aim to educate, we must acknowledge and highlight the inherent dangers composting dog-poo to keep our consumer safe and informed. We must also be conscious of avoiding green-washing and not misleading consumers by avoiding buzz words like 'eco-friendly'.

Research shows that the poo-bag highly saturated with similar products. However, there is only a few brands that offers paper-based alternatives which may be due to inherent stigma paper as has against plastic.

Brand Collaboration

As outlined in the user group rationale (page 2), we aim to collaborate with animal shelters to educate and support potential adopters and fosterers in adopting sustainable pet waste disposal methods at home. We selected **Battersea Dogs & Cats Home** [25] for its influence beyond its three centres, using its platform to campaign, educate and improve the lives of both pets and owners nationwide. Their mission extends far beyond rehoming animals, making them an ideal partner for driving long-term behavioural change.



Visual Identity Analysis

Pentagram developed Battersea Dogs & Cats Home's visual identity and tone of voice, emphasising the charity's commitment to all dogs and cats through hand-drawn watercolour illustrations that evoke a sense of family and community.

"The abstract illustrations are designed to subtly communicate Battersea's story; they appeal to people's compassion and humanity, **without victimising or stigmatising the animals.**" -Pentagram [26]

Critical Reflection: Battersea Dogs & Cats Home communicates complex and sensitive issues with clarity and empathy, balancing the seriousness of animal welfare without victimising the animals or diminishing the issue. This approach is particularly relevant to our brand, as **we aim to communicate the environmental and civic health importance of proper pet waste disposal** in a way that **feels informative and responsible rather than preachy or performative.**

Messaging & Campaigns

In 2026, Battersea Dogs & Cats Home launched the '**Cost of Cute**' campaign to raise awareness of the health impacts caused by breeding dogs with extreme physical features considered desirable or "cute." The campaign focused on educating owners to make informed choices without shaming those who may have previously been unaware of the consequences, demonstrating Battersea's balanced and empathetic communication approach.

Critical Reflection: We envision our product line supporting an awareness-driven campaign that encourages pet owners to consider the impacts of their waste disposal choices. By **focusing on education rather than guilt**, the campaign would promote informed habits. The future product range should extend across the wider home ecosystem, integrating responsible pet waste management into everyday living.

Messaging Strategy

To emphasise the paper-based nature of the product, the branding adopts a vivid watercolour visual language inspired by Battersea Dogs & Cats Home, reinforcing associations with paper, natural materials and familial responsibility. The name "Dooti Calls" is a playful reinterpretation of the phrase "Duty Calls" and "Doody", a slang term for poop.

By establishing a humorous and approachable identity, we aim to reduce the stigma and discomfort often associated with handling dog waste.

Brand Style Development

After ideation, the first logo and mascot iteration was developed independently from Battersea's branding. The superhero-style dog mascot was illustrated over a real dog turd image, with its raised ear forming the letter "i" within the combined logo

Iteration 1

Sketch (Procreate)

Lineart (Illustrator)



Feedback

Users struggled to quickly understand the concept, describing it as overly complex and somewhat gimmicky.

Iteration 2 : Simplification

We adapted Battersea's watercolour language by composing varying turd shapes and sizes into dog illustrations. Through celebrating the diversity of dog breeds, we aim to reinforce that if dog poop is not one-size-fits-all, its solution shouldn't be.

This idea is reflected in the user guide where rather than avoiding the issue, our visual language encourages users to acknowledge dog waste as part of the broader disposal journey, transforming an uncomfortable topic into a approachable and playful educational experience.



DOOTI DOOTI

calling you



[All watercolour illustrations were hand drawn with no use of AI]

CMF Considerations

Colour

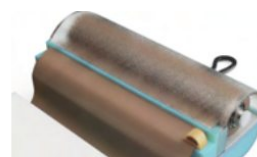
As Dooti was developed in collaboration with Battersea, careful consideration was given to the relationship between the product and its packaging. Portfolio Pg. 9 presents the colour palettes of both Battersea and Dooti, with Dooti's branding taking inspiration from the "Muddy Dog" campaign. To create visual hierarchy and ensure the device stood out against the predominantly earthy tones of the packaging and marketing materials, cerulean blue was selected as the primary product colour. Similarly, the pouch was designed in a bright, vibrant colour to increase visibility and serve as a visual reminder that it contains used dog waste, reducing the likelihood of it being forgotten or misplaced. This approach improves product recognition while maintaining alignment with the overall brand identity.

Material

Silicone was selected as the primary material for the pouch due to its flexibility, durability, and translucent appearance. Its semi-transparent nature allows users to quickly determine whether the pouch is empty while obscuring the contents, reducing the visual discomfort associated with storing dog waste. The material is soft and impact-resistant, allowing it to flex and move naturally during walks without cracking or breaking. Additionally, the pouch can be easily inverted for cleaning, improving hygiene and extending the product's lifespan.

Finish

As a portable utility product, Dooti must perform reliably in a wide range of outdoor conditions. Dog walks often occur in wet, muddy, or cold environments where users may have limited dexterity, particularly when wearing gloves. To improve grip, comfort, and confidence during use, a textured surface finish was applied to the top lid. The side walls of the lid remain translucent, allowing the status LED to be visible from multiple viewing angles. This ensures users can easily see when the heating mechanism is active, whether the device is being carried from a belt loop, hanging upside down, or resting flat on a surface. The combination of textured and translucent finishes enhances usability while reinforcing the product's durable, practical, and approachable character.

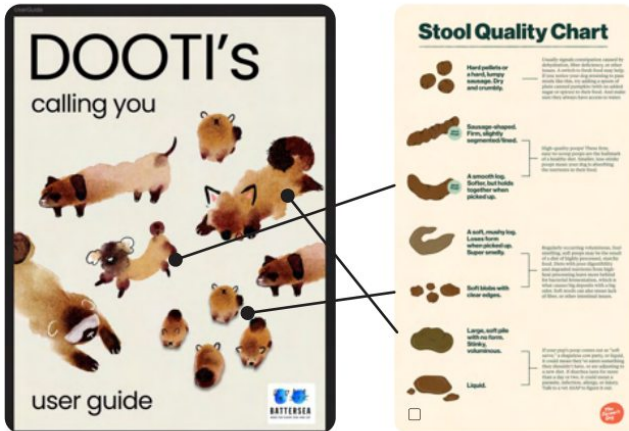


Packaging Style

Battersea uses plastic-free, home-compostable packaging to distribute its merchandise. Dooti adopts a similar approach, reflecting the expectations of the animal shelter environment in which the product is intended to be sold. The packaging prioritises low manufacturing cost and material efficiency while still delivering positive user experience. The implementation of which is shown on **pg.16**

User-guides

Watercolour illustrations and assets were created to emphasise the messaging of the product.



Each dog illustration represents a different type of turd

A key issue with conventional user guides is that they are often discarded or forgotten inside the packaging. As education is central to our product, the guide was designed to remain visible beyond initial setup. Instead of functioning purely as an instruction manual, each section was created to be displayed like artwork, encouraging repeated engagement with the educational content.

Requirements

Educational: Clearly informs users about the inherent health risks associated with composting dog waste while providing guidance on how these risks can be reduced through proper handling and disposal methods. Includes key composting rules such as not using compost on edible plants, alongside visual diagrams identifying which types of dog waste are unsuitable for composting.

Technical: Clearly informs users what is included in the box, how to correctly set up the device and provides intuitive step-by-step instructions for everyday use. Includes key product features, troubleshooting guidance, maintenance instructions and clear visual diagrams to ensure the device can be operated correctly.

Safety Notes: To ensure safe and reliable operation, avoid exposing the device to excessive moisture or prolonged rain, and do not touch the sealing area immediately after use as surfaces may become hot. Kept out of reach of young children when in use.



The final page of the user guide features a displayable "turd chart" artwork designed to help users make informed judgements about which types of dog waste are suitable for composting. This was illustrated by referencing existing veterinary stool health guides, including dog poop colour charts [27] and Lyka's Ultimate Poop Chart [28].

Labelling

Product Compliance & Regulatory Markings

FCC are mandatory labels required for electronic products imported and sold to the US. In 2026, the United States was estimated to have the highest dog population (89.7 million) [29] in the world, making it a key market target for Dooti.

UKCA [30] and **CE** [31] markings demonstrate that a product complies with the relevant regulatory requirements. In the compliance review, Dooti is classified as electronic equipment so it has to comply with GPSR, EMC, RoHS, WEEE, and battery regulations.

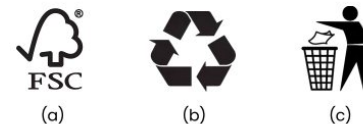
Battery Disposal: As Dooti is powered by alkaline batteries, they do not qualify as hazardous goods and **do not** require a **UN** label. However, the **WEEE** label [32] must be printed to indicate that the battery cannot be discarded in general waste and must be recycled separately for recovery.



Packaging and Disposal

As both Dooti's packaging and refill rolls are paper-base solutions, the **FCS** label [33] indicates that paper/cardboard material utilised were responsibly sourced from recycled or sustainably controlled sites. Whereas, the **Mobius loop** [34] indicates that the majority of the packaging is recyclable, following the **Packaging and Packaging Waste Regulation** (2025/40).

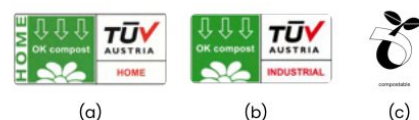
The **Tidyman** symbol [35] is used to promote responsible disposal and anti-littering. However, within Dooti's context, it may misled users to discard the bags in general waste rather than compost them. As such, the packaging should be designed to clearly **differentiate disposal guidance** for the outer **packaging** and the **compostable bag** material to avoid user confusion.



Compostability Labels

The **TUV Austria certification** helps distinguishes materials that can decompose under lower, less controlled home composting conditions from those requiring industrial composting environments. Displaying the **OK Compost Home** [36] symbol reassures users that Dooti's poop bags are designed to break down in a typical backyard compost system.

The **Compostable Seedling** indicates compliance with **EN13432** validated through our compostability testing [37]. At the minimum, the bags will biodegrade under controlled industrial composting conditions.



Target Audience

Target Market: Animal shelters act as the primary distribution channel, purchasing Dooti in bulk to resell or provide as part of adoption packages. Integrating the product into the adoption journey introduces responsible waste disposal habits from the beginning of pet ownership. Unlike traditional retail packaging, Dooti does not need to compete for shelf attention, meaning that packaging design should prioritise affordability, material efficiency and educational communication.

Target Users: Packaging responds to two user interaction: first as a retail/display product within shelters and online platforms, then as a home-use product purchased by dog owners. For users, there is a need for simplicity(intuitive functionality) and reliability(no product damage).

Brand Messaging: As Dooti centres around responsible dog waste composting, it is important that the packaging reflects the same circular values by designing for recyclable and compostable end-of-life pathways.

Derived Requirements

Low Manufacturing Cost: Reduce material, tooling and assembly complexity.

Design for Disassembly: Easy material separation

Circular End-of-Life: Uses recyclable or compostable streams

Material Purity: Avoid excess coatings, adhesives and contaminants.

Securement: Secure contents during transportation

Packaging Labelling

A3 pg. □ portrays the enlarged product information printed onto the paper sleeve in three sections.

The front of the packaging communicates the product branding, technical product name and included contents. A QR code provides access to additional resources through the Dooti website, including a digital user guide, composting guidance, educational articles, and supporting product information. To avoid overwhelming new users, the printed user guide contains a carefully condensed version of this information, focusing on essential setup instructions, key features and important safety warnings needed to get started confidently and safely.

The side panel of the packaging communicates essential compliance and disposal information (see p.15) [38]. To minimise user confusion, disposal guidance is separated into three categories: the Dooti Maker, bag refills, and the packaging itself. Additional information includes the batch number, product barcode, company details, and relevant safety warnings.



[Figure 2.1 Compliance labelling for packaging]

Design Rationale

Packaging assembly has been **simplified to 3 components to reduce cost:** sleeve (labelling), box (containment) and **frame** (support).

Paper Sleeve

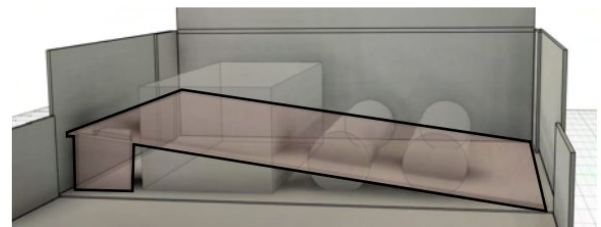
A removable paper sleeve was selected to communicate branding, product information, and regulatory markings independently from the structural packaging. This eliminates the need for adhesive labels or stickers, enabling easy material separation at end-of-life while improving recyclability and reducing contamination.

Cardboard Box

A rollover hinged-lid mailer box [39] was selected, using folded interference-fit features instead of adhesives for assembly. The unprinted cardboard construction eliminates ink contamination, creating a clean material stream suitable for recycling or composting.

Cardboard Frame

A diagonal support frame secures the product through an interference fit, removing the need for adhesives or additional materials. The cut-out geometry provides a snug fit while integrated finger holes improve product accessibility. After unboxing, the frame can be repurposed into a display stand for the educational user guide, extending the packaging lifecycle.



[Figure 2.1 Cardboard frame locking in the Dooti Maker and Rolls]

CMF Considerations

Colour: Printing is limited to the removable paper sleeve to reduce unnecessary material treatments. The box and support frame remain natural, unprinted cardboard. The natural earth tones reflects Dooti's idea of material honesty which is core to transparent education.

Material: Utilises FSC-certified recycled cardboard [40] for box and frame structure and thin textured paper for the informational sleeve. Water-based PVA adhesive is used to bond the sleeve's end.

Finished: Uncoated matte finish with visual grain textures reinforces connotations of paper which is the main material of our pet poo bag product. However, as we employ water-base ink with no lamination, it may not be fully waterproof. This is expressed through the **umbrella label** that indicates that the package is sensitive to moisture and must be kept dry. [41]



[Umbrella Label]

Production Process

Branding Sleeve:

1. Branding and product information is printed onto FSC-certified uncoated paper (120 gsm) using **offset lithography** with water-base inks.
2. **Steel-rule die cut** sleeve profile onto printed sheets
3. **Crease, folding** and **join** with water-base adhesive to form rectangular profile.

Cardboard box:

1. **Die cutting** cardboard sheet into mailer box nets.
2. Crease fold lines to define hinge and assembly area.
3. Box folded using interference-fit tabs.

Cardboard Support Frame:

1. **Die cutting** cardboard sheet into custom frame net
2. Crease fold lines to define hinge and flaps.
3. Frame folded using interference-fit tabs.

1 adhesive bonding

2 outsource process:
Die-cutting and Printing

As both the outer box and internal frame are die-cut from the same material, production can be consolidated at a single manufacturing facility, reducing tooling, logistics and transportation costs.

Packaging Cost Estimation

Assuming low-batch production of 1000 unit. The total estimated cost of packaging independent from the product is 25.7p, which around <1% of overall cost. If it was a medium-batch production of 10,000 units, then cost per unit is 12.6 p (51% decrease).

Component	Material	Area (m ²)	Board	Print	Die-cut	Gluing	Overhead	Total/Unit
Sleeve	White-line	0.098	1.6p	3.2p	2.0p	1.0p	0.2p	8.0p
Box	Uncoated	0.153	2.9p	N/A	6.5p	N/A	1.0p	10.4p
Frame	Uncoated	0.043	0.8p	N/A	6.0p	N/A	0.5p	7.3p
			5.3p	1.1p	14.5p	1.0p	1.7p	25.7p

Summarised Specification

Low Manufacturing Cost

- Packaging is limited to two material types and two manufacturing processes.
- Total packaging cost is estimated at £0.257 per unit at a production volume of 1,000 units, placing it at the lower end of the typical consumer electronics packaging cost range (£0.20–£3.00).

DFD and E.O.L

- Components separable without tools
- Disposal method conveyed through labels
- All recyclable material with minimal contamination

Material Purity

- Uncoated fibre-base materials
- Single adhesive application point

Securement

- Maintains structural integrity when inverted
- Minimal movement of internal parts in transit
- Survives 1 m drop test

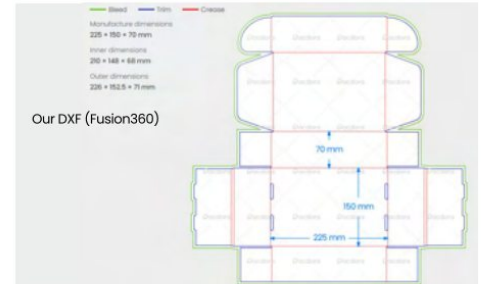
Prototyping Process

We translated the 3D packaging structure into manufacturable 2D dielines, defining cut paths, crease lines and assembly features for our prototyping process.

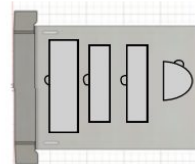
Sleeve



Box (Referenced from Packdora [1])



Frame



Fingers holes were incorporated to help users pry the product out of the frame.

We tested the assembly time using a half-scale model. After several practice runs, the fastest packaging assembly time achieved was **1:50 min**.

Building box: 30 sec
Folding sleeve: 20 sec
Glueing Sleeve: 10 sec
Folding Frame: 20 sec
Inserting components: 30 sec

Total time: 1:50 min per unit

Assumptions:

The box net and internal frame had already been pre-cut and pre-creased, while the sleeve was supplied as a flat strip.

Total Product Cost

DOOTI Cost Estimation (10,000 units)		
Cost Category	Item / Scope	Estimated Cost (£)
Material Cost	Casing, bag material, pouch material, and 2 refills	£3.54
Manufacturing Cost	Injection moulding	£6.51
Electronic Cost	MOSFET, thermistor, switches, LED, heating wire, PCB/stripboard, wires	£2.30
Packaging Cost	Paper sleeve, cardboard box, cardboard frame, printing and labels	£0.13
Assembly Cost	Estimated labour time for final assembly	£1.00
Costing Method		£13.48
Use CAD or slicer output for material mass, supplier BOM prices for electronics, packaging estimate for fibre components, and time-based labour cost for assembly.		10%
		£1.35
		£14.83

Cost estimates are based on a medium-scale production run of 10,000 units, with a 10% contingency allowance for material waste, price fluctuations, and estimation uncertainty. The primary cost drivers are the injection-moulded casing and electronic components. Each refill roll contains 3.5 m of four-layer material (two paper layers and two NatureFlex cellulose layers), equating to 0.84 m² of paper and 0.84 m² of cellulose film. Based on bulk material costs, the refill roll is estimated to cost approximately £0.90–£1.00 per roll, with a nominal cost of £0.92.

Objective & Feature

The DOOTI device was developed to address the common challenges faced by dog owners when disposing of pet waste, particularly the over-reliance on single-use plastic bags and the lack of convenient support for composting. The goal was to create a product that makes dog poo collection, sealing, carrying, and composting more hygienic, less unpleasant, and easier to integrate into daily walking routines. Key features which support this purpose include:

- **Refill-based bag system** uses a continuous roll of paper and NatureFlex cellulose film, allowing users to pull out only the amount of bag material needed.
- **Integrated heat-sealing** mechanism seals the inner compostable film layer, helping contain smell and reduce direct contact with dog waste.
- **Built-in cutting blade** allows the sealed section of the bag to be separated cleanly after use.
- **Raised pulling ring** design gives users a clear grip point to pull the bag sheet through the device, making the interaction more intuitive and controlled.
- **Layered bag structure** combines an outer paper layer for picking up waste with an inner NatureFlex film layer for sealing, improving hygiene while supporting compostable disposal.
- **Portable pouch system** provides a discreet place to carry the sealed waste bag home, reducing the urge to immediately throw it into a public bin.
- **Temperature-controlled electronics** use a thermistor, Pico, MOSFET, and safety cut-off logic to prevent overheating during the heat-sealing process.

Prototyping Components

- **Bag Maker Device**
The maker prototype integrates the bag roll, blade, heat-sealing system, and electronics into one device. It tests the key pull, seal, and cut interaction, with safety controls such as timed heating and a 75°C cut-off.
- **Pouch**
The pouch supports users after waste collection by providing a discreet and hygienic way to carry sealed bags home. It directly responds to user concerns about smell and the discomfort of carrying dog waste.
- **Packaging**
The packaging communicates the DOOTI brand, product use, refill system, and composting purpose. It helps users understand the product as both a device and a sustainable behaviour-change system.

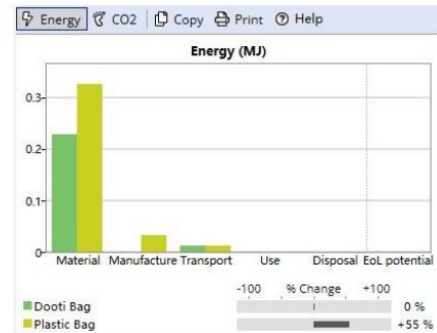
Conclusion

Overall, the project successfully developed a complete product system that supports dog owners in collecting, sealing, carrying, and composting dog waste. The maker prototype proved the main pull, seal, and cut interaction, while the pouch improved hygiene and carrying, and the packaging communicated the composting purpose. However, the design still has limitations: the maker prototype could be further refined in terms of manufacturability, while the pouch requires more testing to prove smell containment, cleaning, and long-term durability.

Business Model

Eco Audit Result (for bag)

Compared with a conventional PE plastic bag, the Dooti bag shows lower overall environmental impact. The total energy use is reduced from **0.373 MJ** for the plastic bag to **0.241 MJ** for the Dooti bag, while CO₂-eq is reduced from **0.0125 kg** to **0.0082 kg**. The main impact for both options comes from the material phase, meaning material choice is the key factor in improving sustainability.



Eco Audit Result (for device)

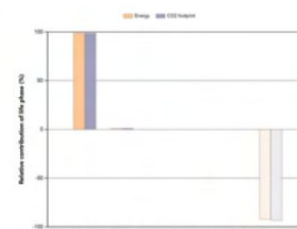
Material dominates the impact, mainly due to the electronics. This is acceptable as the electronics provide the key product functions.

Manufacturing impact is low, showing that the casing and small-part processes are not a major concern.

Transport is zero because no distance was included, so this is a limitation of the audit.

Use impact is very low because heating only happens for short timed periods.

Disposal impact is low, but the product should still be easy to separate for recycling and electronics recovery. The Eco Audit result is positive overall, as manufacture, use, and disposal impacts are very low. Electronics have the highest impact, but this is reasonable because they enable heating control and safety.



Cost Justification

The refill roll is the repeat-purchase part of the business model. Based on the selected material structure, the roll uses paper + NatureFlex cellulose film, with an estimated material cost of around **£0.90–£1.00** per roll. This keeps the refill affordable while supporting a more sustainable disposal behaviour.

Business Value

This supports a refill-based model: users buy the device once and continue purchasing lower-impact refill rolls. The eco audit provides the environmental reason to switch, while the cost comparison shows that the refill system is commercially realistic.

Compostability Testing

Testing Process:

The cellulose film was submerged in a diluted solution of fermented pineapple enzymes (commonly known as eco-enzymes). These enzymes contain bromelain and organic acids that help accelerate the breakdown of organic materials and promote microbial activity. The solution was diluted to avoid excessive acidity while still providing an active degradation environment.

Limitation:

Due to project time constraints, a full compostability assessment was not possible, as home composting trials typically require up to six months to evaluate material breakdown. Instead, an accelerated degradation test was conducted on the cellulose film. While the manufacturer states that the material is home compostable, this test was used to gain an early indication of how the film responds to biologically active composting conditions.

Results (1 Week):

Noticeable changes in the film's tactile properties were observed after one week, indicating the onset of material degradation. While this does not confirm full compostability, the results provide evidence that the cellulose film is susceptible to biological breakdown. Under the extended timescales, elevated temperatures, and microbially rich conditions found in a real compost heap, the material is expected to continue degrading and eventually compost as intended.

Inclusion Testing

Testing Process:

We tested the bag geometry using faux dog waste of varying sizes and moisture levels to assess performance within the 120 mm bag opening constraint.

Limitation:

Due to hygiene and ethical considerations, testing was conducted using flour-based faux waste. While informed by veterinary stool consistency charts, it could not fully replicate the texture, odour, and handling characteristics of real dog waste. Future testing should use real dog waste for validation.

Results:

The bag effectively handled small to medium-sized waste and could collect larger deposits, although some remained visible through the transparent cellulose film. It also performed well with moist waste up to the early stages of diarrhoea. Beyond this point, users achieved better results by using the paper sleeve as a scoop before transferring the waste into the bag.

Future Improvements

- Use a tinted or opaque film to reduce waste visibility.
- Explore wider openings or integrated scooping features for larger breeds.
- Validate performance with real dog waste.

Public reception

Positive: Overall public reception during GEF was positive towards Dooti's mission. Many attendees who already composts expressed strong support for the concept, recognising the environmental value of diverting dog waste from landfill. Many visitors asked when the product would be available on the market, indicating genuine interest and commercial potential. Several attendees also commented that "you don't really think about dog poo," highlighting how overlooked the issue is and reinforcing the need for greater awareness.

Negative: Casual dog owners were harder to convince, as the perceived inconvenience of composting often outweighed its benefits. Some questioned what would stop users from simply throwing Dooti bags into general waste, reinforcing the importance of education and personal responsibility in ensuring the system's success.

Future Plans: Business Case

Owning the Entire Composting Journey

One key issue that repeatedly emerged during user feedback was how to motivate users to start composting in the first place. Presently, Dooti's bag-making device is still dependent on users being willing to invest the time, effort and resources needed to learn how to maintain a compost heap that operates safely. We acknowledge while Dooti simplifies waste collection, it does not yet physically support the composting itself outside of the educational material we provide.

Subsequently, the next step in Dooti's business plan is to expand beyond collection to offering composting solutions. This could involve us designing specialised composters for dog waste and helping our customers set up easy to use, quality-assured composting systems at home. While electric composters already exist for handling food waste, there are currently few smart devices intended for dog poop. Therefore, there is a gap in the market for a dedicated dog-waste composter with automated temperature and humidity control that helps ensure optimal composting are reached and maintained. This would help improve pathogen reduction while increasing user confidence and accessibility.

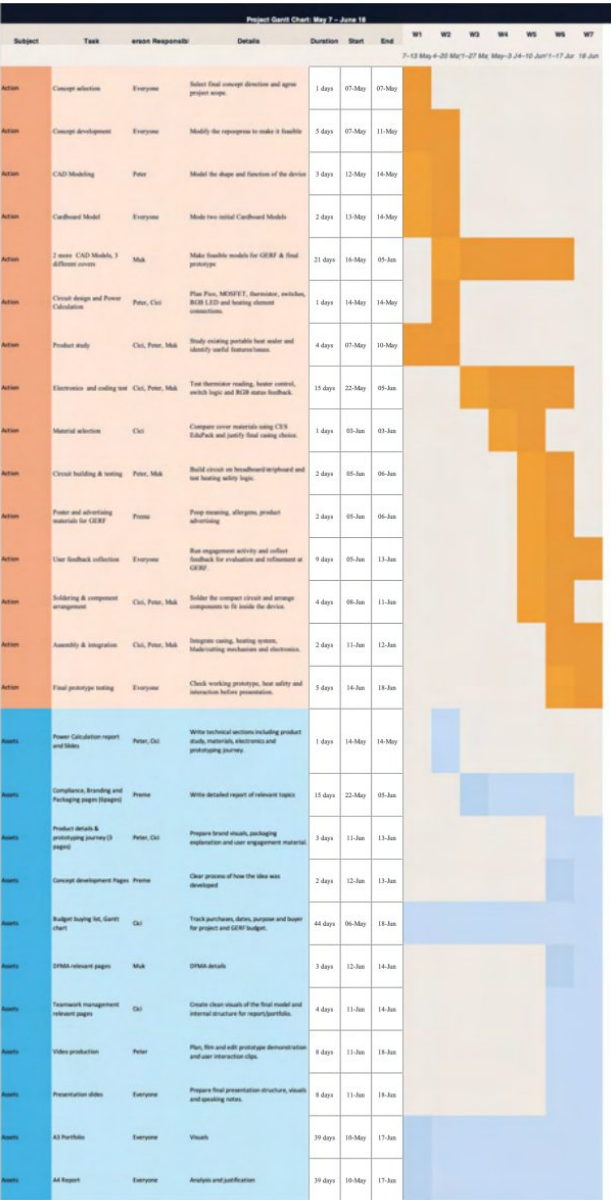
Expanding Sectors

A natural extension of Dooti's mission to reduce material waste is to partner with local farmers' markets and independent bakeries. The variable sizing of Dooti's compostable bags makes them well suited for packaging baked good and produce of different shapes and dimensions. By repurposing the same packaging technology beyond pet care, Dooti can enter new markets while reinforcing its commitment to waste reduction and circular design. Such partnerships would increase brand visibility, diversify revenue streams, and demonstrate the versatility of compostable materials in everyday applications.

Project Management

Planning: Gantt Chart

The **Gantt chart** shown was created in Microsoft Excel [42] to support team **planning and project tracking** throughout the project. It divided the workload into key actions and final assets, including prototyping, user feedback, the report, portfolio, video, and presentation slides. This allowed the team to clearly understand what needed to be completed at each stage and how **different tasks overlapped** with each other. By setting deadlines, responsibilities, and individual task details for each team member, the chart helped the team **monitor** progress, manage workload distribution, and keep the project moving in an **organised** and structured way.



Managable Prototyping Plan

Prototyping was the most important and intensive part of the project, and the Gantt chart shows that it followed a clear **step-by-step workflow** from CAD modelling and electronics planning to circuit testing, soldering, and final assembly. This structure helped the team test each function separately before integration and **manage risks**, although practical issues still occurred, such as incorrect or damaged components, which required plan adjustments and reordered parts.

Our Plan: We started testing the electronic components early to allow time for mistakes, troubleshooting, and component replacement.
Reality: Several issues still occurred during prototyping. The wrong MOSFET was purchased initially, some resistor values were missing, and troubleshooting was difficult at first because we did not have a voltmeter.
Things to Improve: In future prototyping, the team should check how each component will be used in the circuit and confirm the exact model before purchasing. A simple component checklist and basic tools such as a voltmeter should also be prepared earlier to make troubleshooting faster and reduce delays.

Effective Plan for User-Feedback

We used GERF as the main source of user feedback, as there was a high chance of encountering some dog owners there.

Focus: Finding a suitable waste pick-up solution.
What we did: A “poop picking challenge” was introduced to let users try picking up the waste themselves, so we could collect direct complaints, reactions, and ideas. Brownies were shaped like poop to simulate the texture and form of real waste, and each volunteer received a free brownie as an incentive. This attracted many people to participate and provide feedback.
Outcome: Participants suggested different pick-up methods. From this feedback, we identified a better solution: separating the paper and film layers, using the paper to pick up the waste, and then placing it into the film-based bag.

Budget

The **£200** of project budget and **£100** of GERF budget were well planned for prototyping, advertising, and gathering user feedback. A purchasing list was created to track costs and manage spending throughout the project. This helped the team control material costs while prioritising the functional parts needed for testing and prototyping.

Project Budget (£200) [43]: Most of the budget was spent on electronic components, which was expected from the beginning because the casing and other structural parts could be produced through 3D printing.

GERF Budget (£100) [44]: The budget was spent on customised advertising team T-shirts and ingredients for the brownie-based “poop picking challenge”. These expenses supported branding, user engagement, and feedback collection by making the activity more memorable and interactive.

Method

During the project, we held regular meetings more than twice a week to share progress, align tasks, and work together when needed. All members contributed actively to their roles throughout the design process.

- Figma was mainly used to create the portfolio, slides, early drafts, posters, and GERF advertising materials.
- Microsoft Teams was used to store shared files, including meeting minutes, the budget list, and the Gantt chart.
- A Gantt chart [1] was used to track tasks, progress, and the project timeline.
- Eight meeting minutes [4] were created to record discussions, task progress, and next actions.
- Budget lists [2][3] were created to manage expenses for prototyping and GERF.

Team Responsibilities

Preme (CCO)

Actions:

- Branding strategy, implementation, and visual presentation
- Concept development, narrative writing, and storyboarding
- Compliance, packaging, and product labelling research
- User guide production
- Packaging and Pouch Implementation

Assets:

- Brand identity and conceptual summary
- User guide, storyboards and Watercolour illustrations
- Compliance and packaging research
- Packaging and pouch prototypes
- GERF presentation materials

Cici (COO)

Actions:

- Monitoring the process using gantt chart, meeting minutes and budget list.
- Helping with Electronics component testing with code
- Soldering all component onto the stripboard
- Filming each stage of prototyping and user-feedback
- Completing material selection in CES Edupack

Assets:

- Product details & analysis and prototyping journey
- Electronics compliance
- Teamwork relevant pages
- Circuit & Power Calculation

Yuxuan (CIO)

Actions:

- CAD modelling to develop the looks like model and function of the device.
- Working on circuit design and power calculation.
- Studying the existing product to identify useful features and issues.
- Helping with electronics and coding tests.
- Building and testing the circuit.
- Supporting soldering, component arrangement, assembly and integration.

- Supporting user feedback collection and final prototype testing.

Assets:

- Circuit and Power calculation relevant slides
- Prototyping journey and Product details & Analysis
- Video draft production

Muk (CTO)

Actions:

- Developing CAD models and different cover options for GERF and final prototype.
- Studying the existing product to identify useful features and issues.
- Helping with electronics and coding tests.
- Building and testing the circuit which emphasis on assembly
- Supporting soldering, component arrangement, assembly and integration.
- Supporting user feedback collection and final prototype testing.

Assets:

- DFMA, assembly, prototyping form and pouch
- Concept development pages

Challenge

We initially chose RePooPress, a concept based on making paper bags with heat sealing. However, we later found that a large heating area was not feasible for a battery-powered device, so the idea had to be modified. The team also struggled to decide whether to continue developing our own concept or switch to another design.

What we did:

After the second tutorial, we made the final decision to continue with the modified version of our original idea, Dooti. Although the decision was made later than ideal, the team was able to settle on one direction quickly once the issue became urgent.

Reflection:

This gave the team a clear direction, but the delay reduced the time available for prototyping. In future projects, we should set a stricter decision deadline in the first week and compare concepts earlier based on feasibility.

Reflection

Overall, the project showed **strong teamwork and collaboration**. Although we faced **challenges** such as late concept selection, component issues, and prototyping delays, the team **responded quickly** by communicating regularly, sharing tasks clearly, and **supporting** each other during testing and assembly. The use of Gantt planning, meeting minutes, and budget lists helped us stay **organised** and keep the project moving forward. In future projects, we would make key design decisions earlier and check component specifications more carefully before purchasing, but this project helped us improve our teamwork, planning, and problem-solving skills.

Appendix-1

AI Acknowledgement

The following Artificial Intelligence tools were used for the following purposes:

- I acknowledge the use of ChatGPT (OpenAI, <https://chatgpt.com>) as a search engine for secondary research, condensing/revising text and content to improve readability, generate images and icons and generating prompts for vizcom.
- I acknowledge the use of Vizcom (Vizcom.com, <https://vizcom.com/>) to generate final product advertisement images based on 3D-CAD models

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Bill of Materials						
Edit quantities and unit costs; total costs update automatically.						
Part Name	Qty	Material	Mass (g)	Material Price (GBP)	Manufacturing Price	Manufacturing Method
Main Lid	1	PC (low viscosity,moulding and extrusion)	20	£ 0.05	£ 0.71	Injection Moulding
Refill holder	1	PC (low viscosity,moulding and extrusion)	77	£ 0.18	£ 1.17	Injection Moulding
Holder Fixer	2	PC (low viscosity,moulding and extrusion)	2.8	£ 0.01	£ 0.49	3D printing
Blade Housing	1	PC (low viscosity,moulding and extrusion)	17	£ 0.04	£ 0.70	3D printing
Paper outer layer refill	1	Paper sheet / roll	40	£ 0.06	£ 0.09	Cutting
NatureFlex cellulose film refill	1	Cellulose-based NatureFlex film	35	£ 0.70	£ 0.12	Film cutting / heat sealing
Heating element	1	Nichrome / resistance heating strip	0	£ 0.03	£ 0.05	Cut to length and fixed in device
Cutting blade	1	ABS, Stainless steel	0.37	£ 0.05	£ 0.03	Purchased standard part / stamping
Raspberry Pi Pico	1	PCB with electronic components	5	£ 1.00	£ -	Purchased off-the-shelf
MOSFET	2	Semiconductor component	1	£ 0.22	£ -	Purchased off-the-shelf
NTC thermistor	1	10k NTC thermistor	0	£ 0.04	£ -	Purchased off-the-shelf
Fixed resistors	3	Carbon film resistors	1	£ 0.02	£ -	Purchased off-the-shelf
RGB LED	1	LED package	0	£ 0.04	£ -	Purchased off-the-shelf
Limit switches	2	Plastic and metal switch assembly	1	£ 0.22	£ -	Purchased off-the-shelf
Wires and connectors	1	Copper wire with insulation	0	£ 0.10	£ 0.05	Cut, stripped and soldered
AA batteries	3	Alkaline battery	65	£ 0.30	£ -	Purchased off-the-shelf
Screws / fasteners	2	Steel	0.35	£ 0.02	£ 0.02	Purchased off-the-shelf
Pouch lid	1	PC (low viscosity,moulding and extrusion)	17	£ 0.04	£ 0.70	Injection Moulding
Pouch container	1	Silicone 30A	38	£ 0.19	£ 0.92	Injection Moulding
Packaging	1	Silicone 30A	10	£ 0.13	£ 0.07	Cutting & Folding
			330.52	£ 3.44	£ 5.12	