day lite

in collaboration with

Transport for London

Team 10

Clara, Alison, Ben and Elvis

Prototyping approach

Methods research

Selected approach

Existing products

Types of prototypes

SKETCH MODELS Cardboard and paper models to test basic dimensional function	*RAPID PROTOTYPE* Quickly produce a dimensionally accurate model through 3D printing	*VERTICAL MODEL* Using back end to test front end, proving the function of key components at an early stage
VIDEO Allows close investigation of ideas like interactions and actions in a graphical format	*FEASIBILITY PROTOTYPE* Used to test technical performance and benchmarks i.e a test rig	*MOCK-UP* A fully looks-like prototype to show final aesthetics, useful for investors/marketing purposes.
HORIZONTAL PROTOTYPE The front end, including interface and contact points such as handles and buttons	*STORYBOARD* Demonstrates a typical order that information needs to be presented in	*SIMULATION* Modelling the product in CAD to test fits and tolerances as well as running FEA to test strength

High-fidelity vs. low-fidelity

HI-FI / LOW-FI

HI-FI

+

Engaging: clients can instantly imagine the product as a reality if the quality of the prototype is high.
Testing: user testing will be more applicable and validated with a higher fidelity prototype.

−

Time: we only have 8 weeks to produce a finished prototype, higher fidelity = more time.
Stubbornness: after spending hours making a beautiful prototype, a designer may be less inclined to make necessary changes.

LOW-FI

+

Fast&Cheap: can be made in a matter of minutes to test almost any metric.
Investment: changes are easily made without sunk costs.
Iteration: throw-away nature of Low-Fi allows many cycles of iterations to be made.

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Realism: inherent low quality of prototypes may mean testing results lack validity.
Confirmation bias: over-simplified prototypes may be biased to what the designer already believes is the correct outcome.

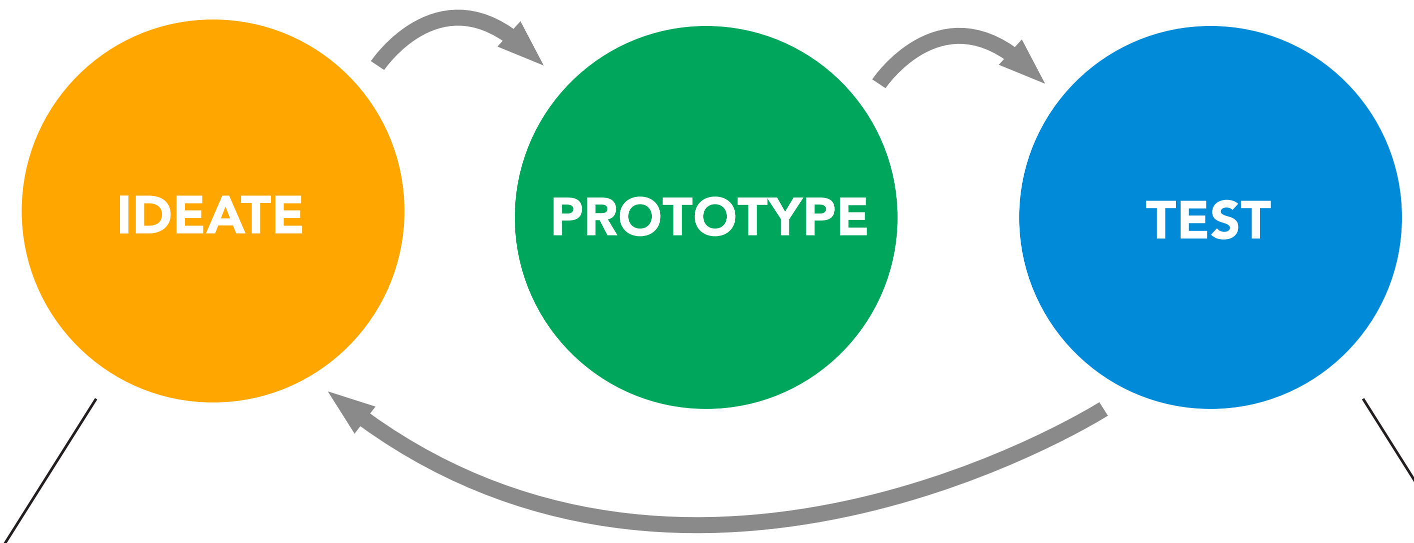
Prototyping approach

Methods research

Selected approach

Existing products

We will use **rapid prototyping** and iterative low-fidelity prototypes to break up the larger design challenge into manageable goals to eventually achieve a single high-fidelity **looks-like** and **works-like** prototype as close to the finished product as possible.

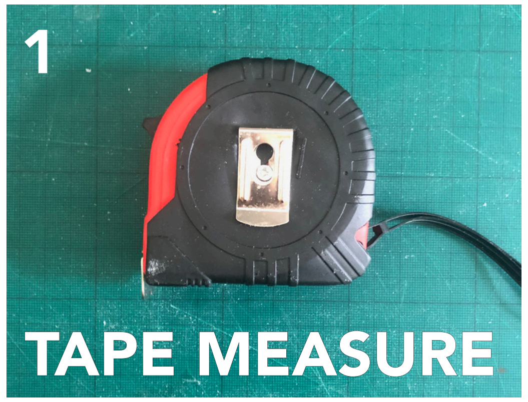


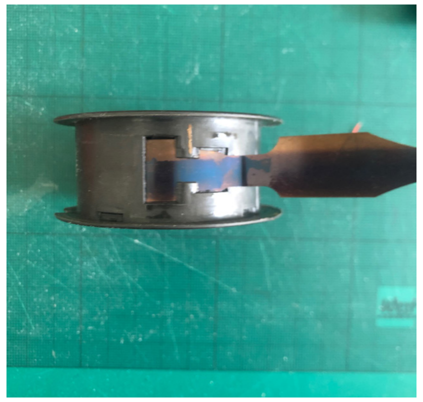
We will not be afraid to **pivot** and redesign where necessary. If our testing reveals that a certain design is not reaching our desired **specifications**, we will improve features accordingly or even **creatively rethink** our idea from scratch.

After creating our Low-Fi prototype, we will **validate** the idea through **rigorous testing** with users or against our power/assembly restraints. This will **inform us** whether the proposed idea is sufficient.

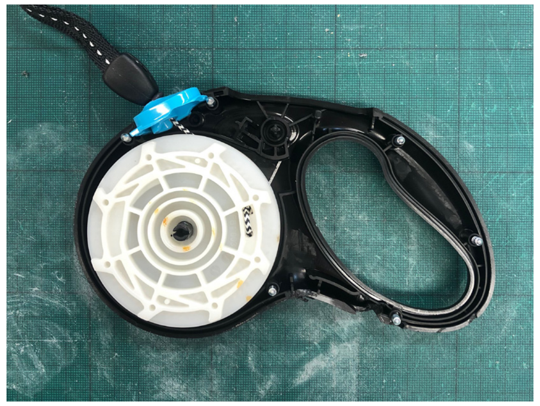
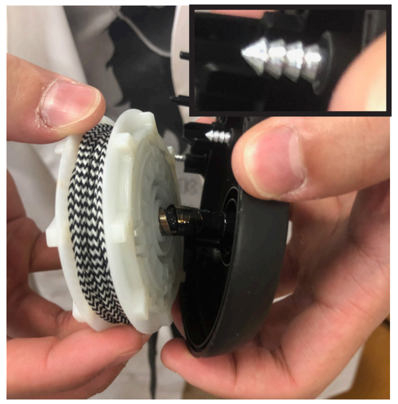
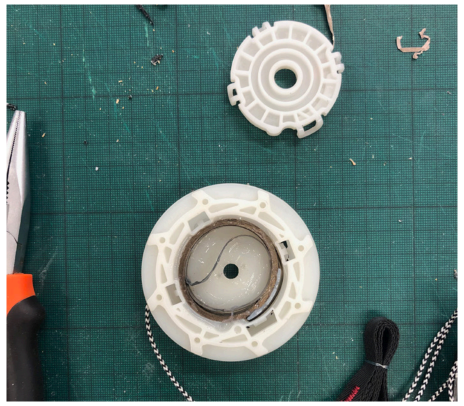
Prototyping approach

In order to further understand how existing injection moulded products are designed, we needed to take some apart. Furthermore, we could extract entire components and use them in our own product.

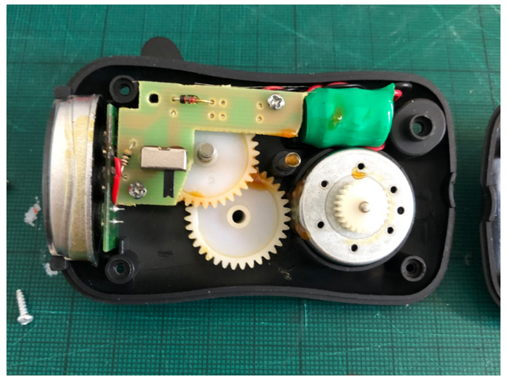



We mentioned 'torsion spring' a lot in phase 2, without actually knowing how they work. The best way to do so was to disassemble an already working retraction mechanism, and learn from it. This example was simply a 0.7mm strip of coiled spring steel.

The previous torsion spring was unusable due to it being injection moulded in place. We purchased this dog leash and the torsion spring was perfect: it was slightly less powerful than the tape measure, but had a removable lid that made prototyping easy. Furthermore, we found these interesting arrowhead pins that were used to join the casing.

This product gave us an insight into what we were trying to achieve - fit all the electronics and mechanisms in a confided space. The battery used was a 3.6V 40mAH stack - our light would need far more power than this. The crank used a series of top hat gears to gain mechanical advantage and spun the dynamo faster.

Performance requirements

Performed tests

Results

Input testing

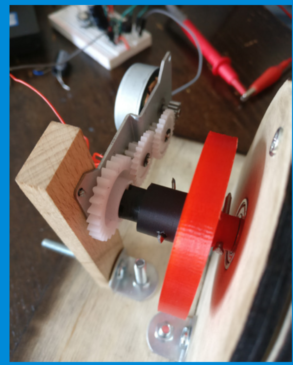
Initially, tests were performed on the input characteristics:

USER INPUT → *FORCE EXERTED*, *POWER PRODUCED*

Donor product:

Dynamo and gear train

To test the power generated by the dynamo, the component was connected to the test rig and wires connected to a multimeter



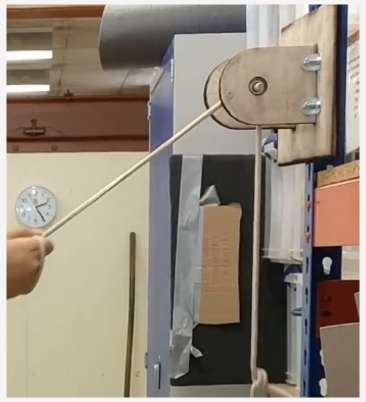
Max voltage rating: 30 V

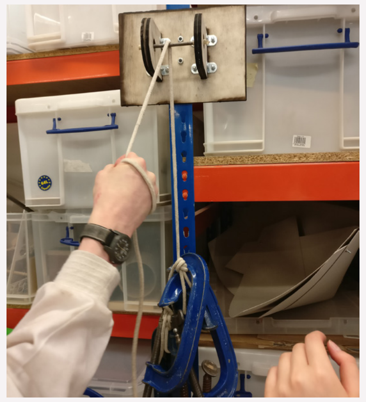
Current rating: 210 mA

Power = ~6 W

Test 1: Pulling weights Vs muscle strain

A test rig was assembled to test how users react to different pulling forces. The pulling angle was set to 60 ° to ensure identical posture was adopted. Users were asked to rate their **comfort level** and **muscle strain** on a **1 to** 10 scale (intervals of 0.5). 30 data samples were collected testing different weights of 1.7, 2.8, 4.1 and 5.7 kg



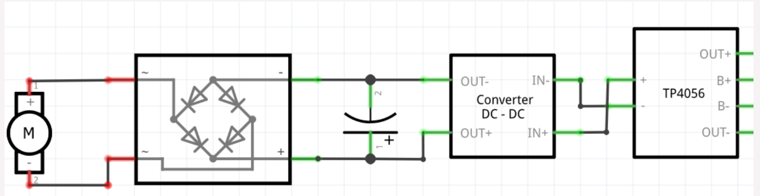


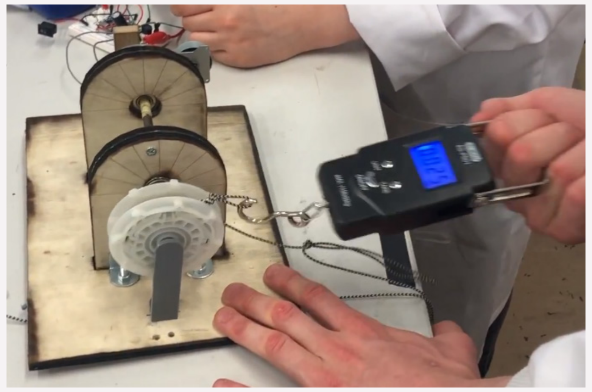
Data was collected and plotted on a scatter graph

	1.66 kg			2.8 kg			4.1 kg			5.7 kg	
	comfort	strain		comfort	strain		comfort	strain		comfort	strain
1	9	5		4	7		1	10		0	10
2	9	2		6	4		2	7		0	10
3	9	0		8	2		4	6		2	9
4	9	1		6	4.5		3	5		1	7
5	10	1		9	1		6	4		3	8
6	8	2		4	6		1	8		0	9
7	9.5	3		7	4		4.5	7		2	9.5
8	7.5	3		7	3		4	7		2	8
9	8.5	2		6	2.5		1	9.5		2.5	8
10	9	0.5		4.5	8		5	6		1.5	10
11	8	1		5.5	4		3.5	7		0	9
12	9.5	0		6	5		0.5	9		2	9
13	8	2		5.5	7		1.5	9		0.5	8
14	9	0		9	2		0	9		2	9
15	9	0		4	7.5		2	8		1	10
16	9	1		8	4		5.5	7		2	8

Test 2: Maximum force Vs power output

The test rig was then adapted to test the power generated when pulled in a similar way to the final product. The dynamo was connected to an initial charging circuit:



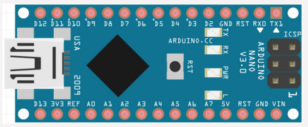


DC voltage and current were measured after the capacitor as this was an indicator of the voltage input to the charging chip. The pulling force applied to the rig was measured with a newton-meter. The maximum voltage and maximum force for 33 instances was noted and plotted.

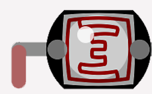
Test 3: Output power requirements

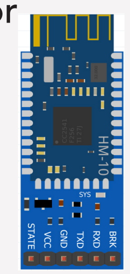
The output power will determine if the input is sufficient. This product needs:

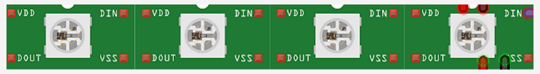
Arduino nano



Photoresistor







3V LED strip 24 bulbs

HM-10 bluetooth module

These parts are connected to the Arduino and were tested separately with an ammeter.

Component	Current rating
Arduino Nano	40 mA
Photoresistor	0.5 mA
LED strip	600 mA
HM-10 bluetooth module	10 mA
Total approx	650.5 mA

This product will need to be powered for around 3 hours of light before user charging is required again:

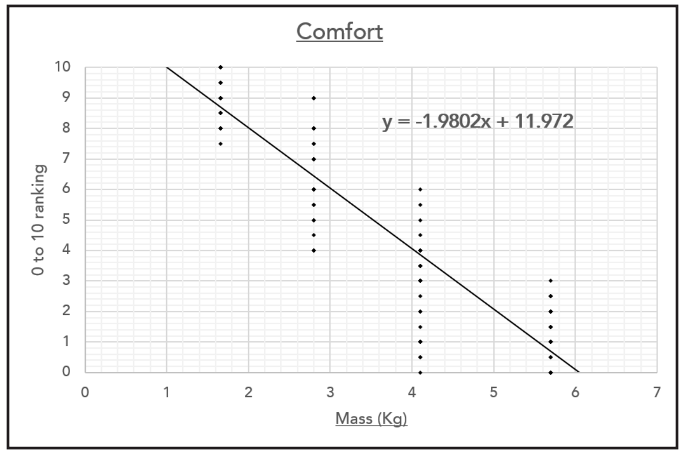
550.5 mA x 3 h = **1951.5 mAh**

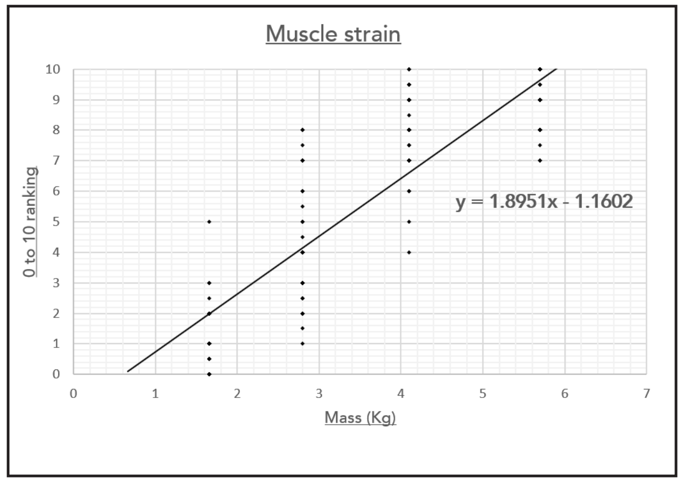
Performance requirements

Performed tests

Results

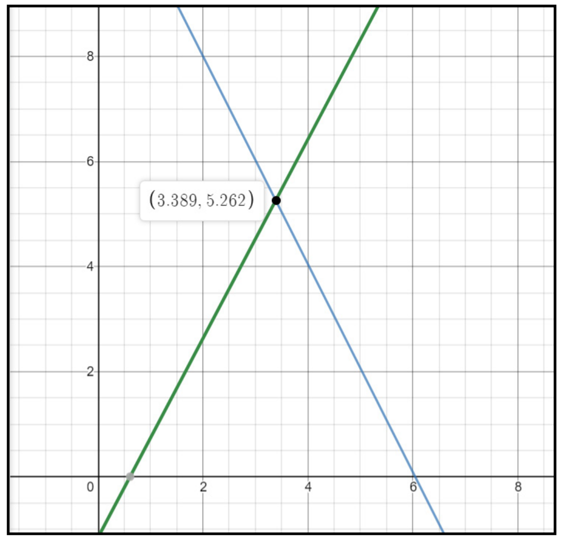
Results 1: Pulling weights vs muscle strain



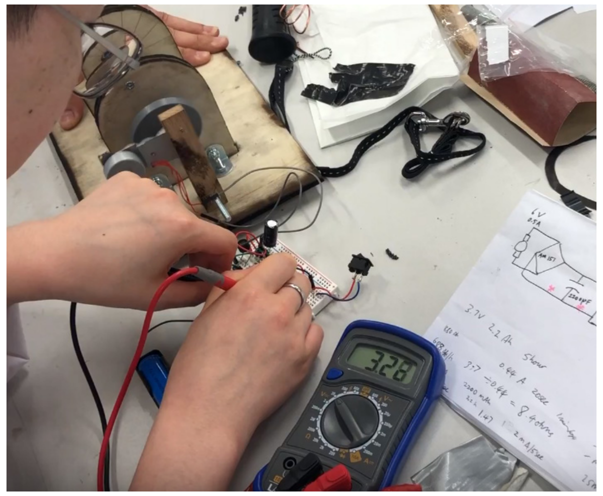


The data was compiled and plotted onto scatter-graphs. For the rating of comfort, the higher the mass, the lower the rating as shown by the negative linear correlation. There were more weights that could have been added but most participants stopped at the 5.7kg mass so data was cut off here. For muscle strain, as more weight was added, the ranking increased as expected with a positive correlation.

The optimum weight was decided to be the most comfort with muscle strain (assuming that more muscle strain stimulates the body more). The lines of best fit were then plotted together and the intersection point noted.

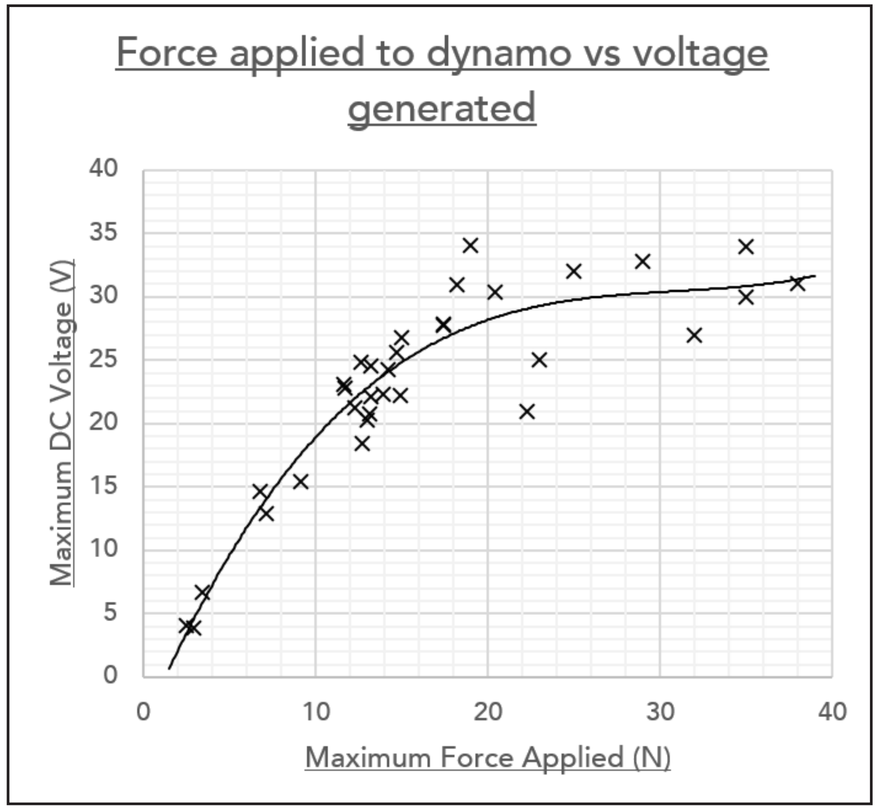


Results 2: Maximum force vs power output



The test verified that the input force will generate more than enough voltage (average = 23V) to charge the donor battery (3.6V). The graph shows a positive relationship that levels out beyond 20 N.

The current generated from the dynamo ranged from 0.18-0.21 A when measured after the capacitor.



Optimum pulling force: ~34 N

↓

Torsion spring should provide around 34 N of force

These values of output and current determine what components (batteries) need to be used in the charging circuit for the stated outputs.

Battery capacity required = ~2000 mAh

Charging time= 2000mAh / 200mA= 10 hours

Although voltage provided is enough, the charging current is not feasible, therefore a different dynamo is required to charge the circuit

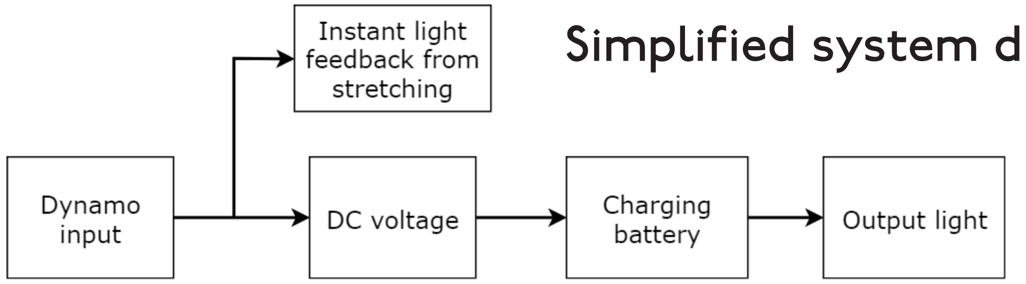
Selection of components

Electronics

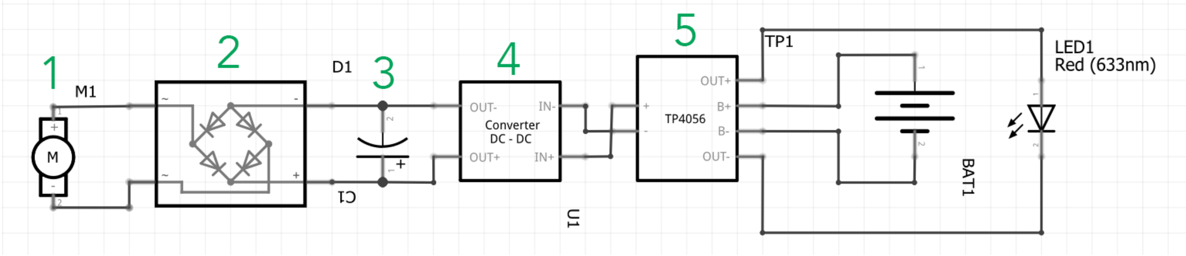
Material selection

When designing the circuitry for the stretching device, the processes were drafted out:

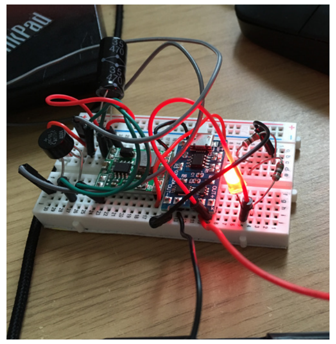
Simplified system diagram



First iteration testing



The components used in the charging circuit are detailed with technical justifications in the table



	Component	Technical details	Purpose
1	Dynamo	(Donor) 6W (NEMA) 1A 3.5V	Provide power input
2	AM151 bridge rectifier	100 V, 1.5 A	Converts AC input to DC
3	470 microF electrolytic capacitor	35 V 85°C	Smooths out DC signal and stores temporary charge
4	MP1584en dc-dc buck converter	Vin=0.3-30V, 4.7 A max	Steps down input DC voltage to 5V
5	TC4056A Li Ion charging module	4 to 8V input, 1.2A max	Charges Li ion battery and supplies load voltage to arduino

Battery selection

Donor product:

3 x 1.2V NiMH battery 320mAh

The wind-up torch batteries were not sufficient as our product required 2000mAh so using Ni-mh is not space efficient either. Also there was no documentation on this specific battery as well as less resources on Ni-mh charging circuits.

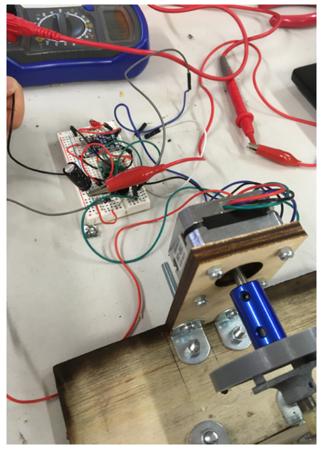
A Li-ion battery was chosen as it stores enough capacity for 3 hours in one single battery. This reduces over/under voltage limit issues from charging multiple batteries in series. Li ion also have faster charging rates and a charging circuitry was easily available (TC4056 IC).

- 18650 Lithium ion battery
- 3.7V nominal
- 2200mAh capacity
- 4.2V charging

Supercapacitors

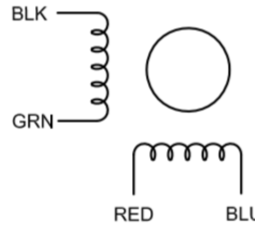
The battery charging chip meant that no matter how high the power, only 1A and 5V could get through to charge the battery.

- *Supercapacitors:* efficient at storing bursts of energy (our scenario)
- *Difficulties:* single supercapacitors have low voltages (2.7 V) so needs to be connected in parallel for enough voltage. They also take a lot of space (35 dia x 60mm for a standard 350F capacitor)



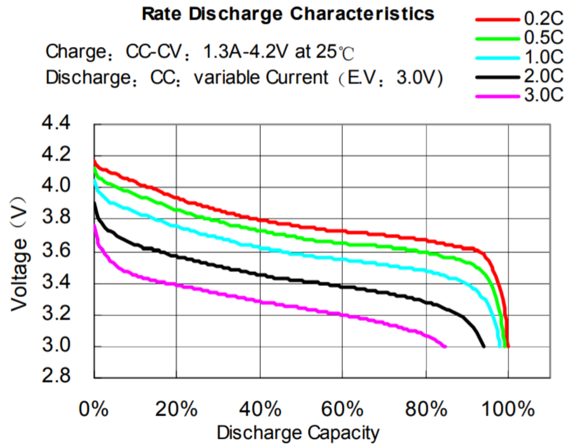
Dynamo selection

From slide [6], the donor dynamo did not produce a high enough charging current. Therefore, other options were tested by changing out the dynamos on the test rig. Reversing a stepper motor (NEMA 17HS08) to produce power sufficed.



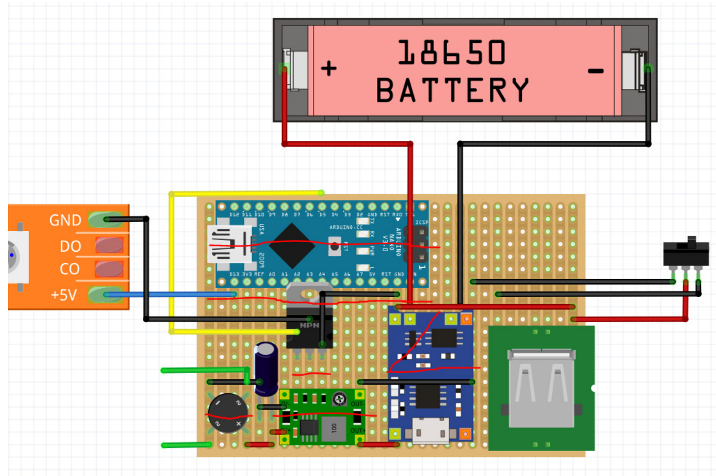
The motor uses 2 coils and power generated was combined in series. Current produced was around 0.9A and voltage 3.5V. Although the voltage is below 5V, this can be stepped up to 5V via an extra E5OD booster module.

Charging testing



The Li-ion could at maximum charge using 1.5A (3C). The charging module provided a maximum of 1A which so battery charges in 2.2/1= 2.2 hours best case scenario. Discharging the battery to 40% and charging the battery via pulling for 15 minutes showed an increase of battery voltage from 3.44V to 3.5V implying the battery charged by around 10%.

The circuitry was configured to attach the load components (arduino, lights, switch) to the charging chip output on strip-board for our final prototype. Details explained slide 10

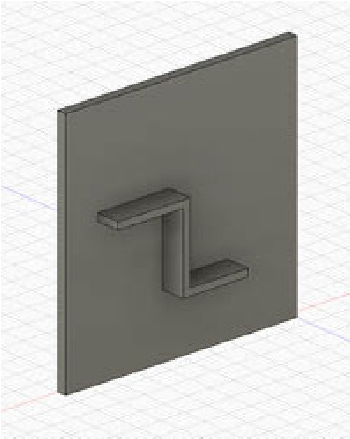


Selection of components

Electronics
Material selection

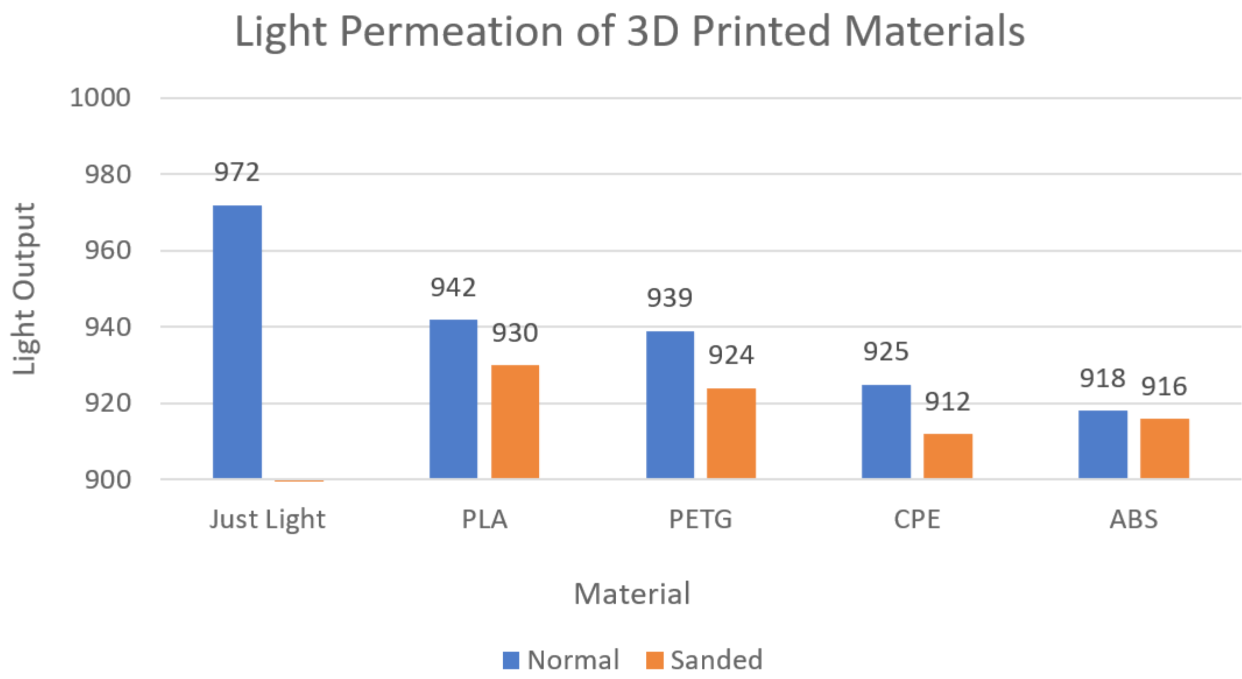
The problem

We needed to select a material that was transparent, but had good light dispersion properties. Therefore, we ordered 6 different material samples and ran a light permeation test to better inform our decision making.



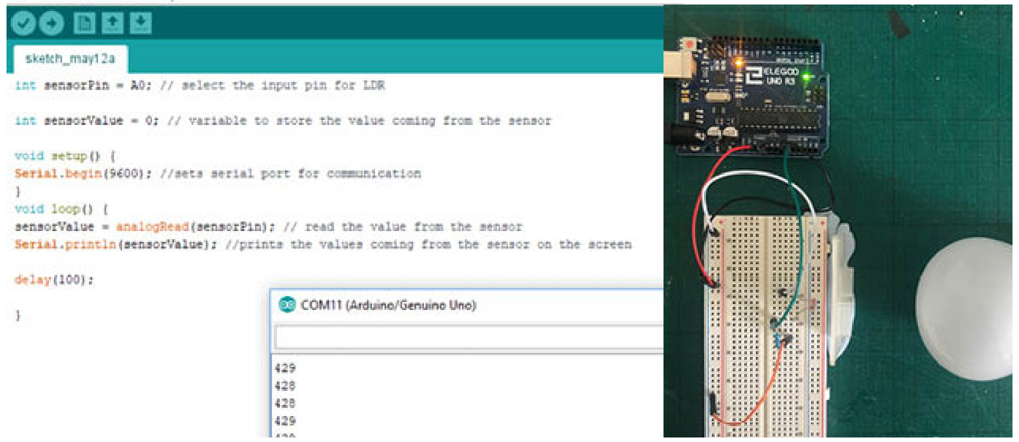
The test piece, 2 mm thick with a test rib.

The results



Only 4 of the 6 materials were printable, Bendlay Flex was too soft to work in the extruder clamp, and PC required a bed temperature of 130° which our printer could not reach. As you can see, PLA and PETG are close contenders, with an output of 942 and 939.

The setup



The test involved shining a 6000K daylight imitating bulb at the test piece, and mounting a photoresistor on the other side. This was connected to an Arduino that mapped the 0V-5V reading into a 0-1024 number on the serial, allowing us to rank each material by how much light got through. The higher the value, the more effective our lights can be.

PLA and PETG were then sanded with 150 grit sandpaper to give a frosted finish. This reduced the visibility of ribs from the exterior of the casing as you can see below. We found that PLA was the best material to use. Furthermore the biodegradable nature of PLA will improve our brand image.

Detail design

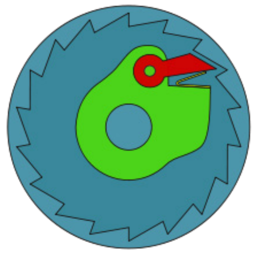
Ratchet design

Casing design

Electronics

Assembly features

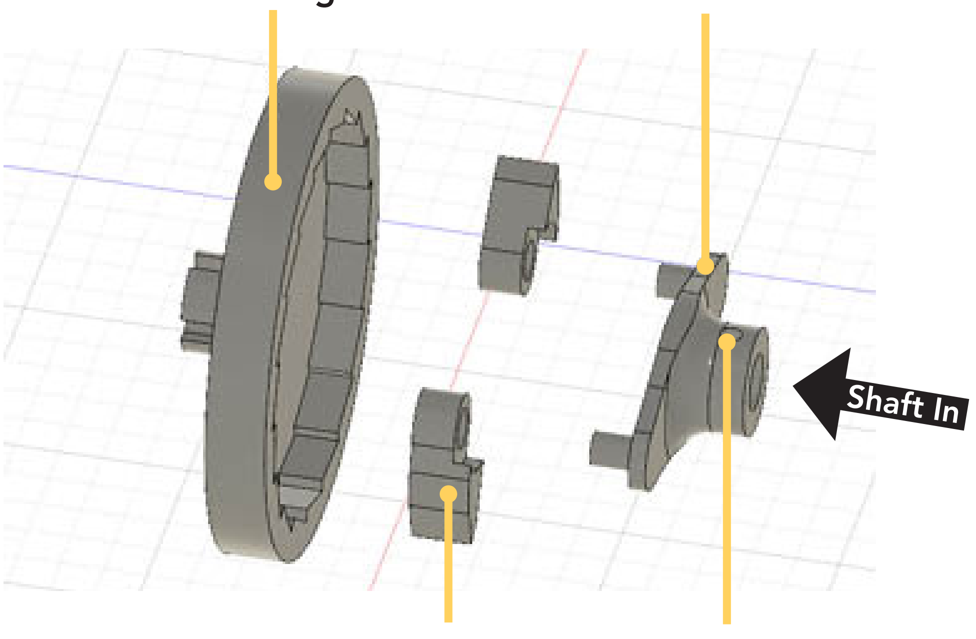
The ratchet was extremely important. We needed to only allow transfer of rotation in one direction so that the torsion spring could retract. Furthermore, it had to be almost frictionless or the torsion spring would not recoil. We began by investigating current designs:

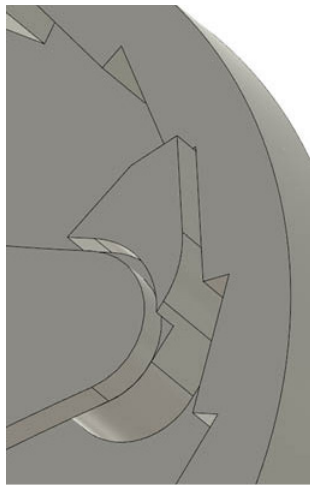


Spring Loaded

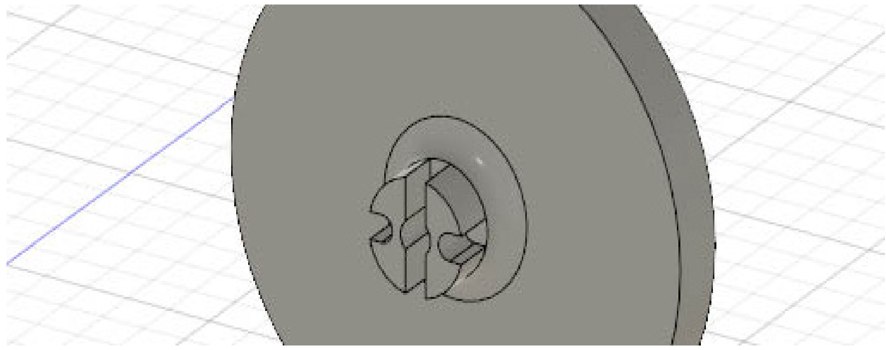
Compliant over-running clutch

Bicycle Free-wheel



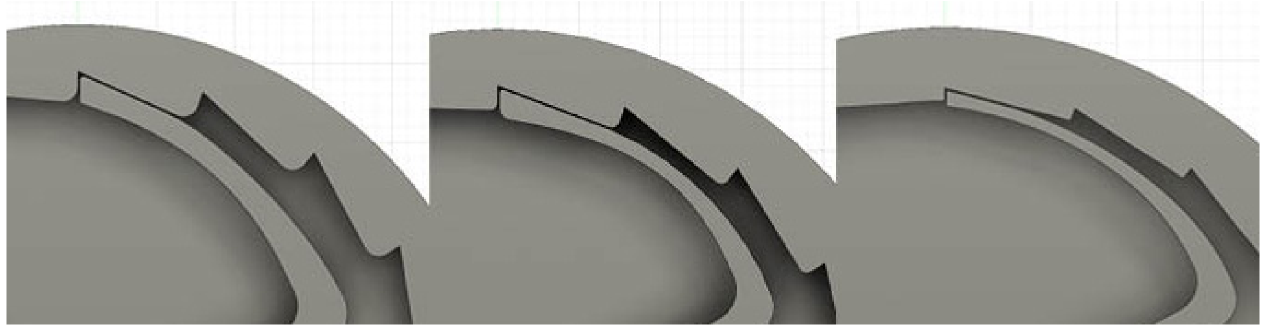


Close up of the pivoting tooth

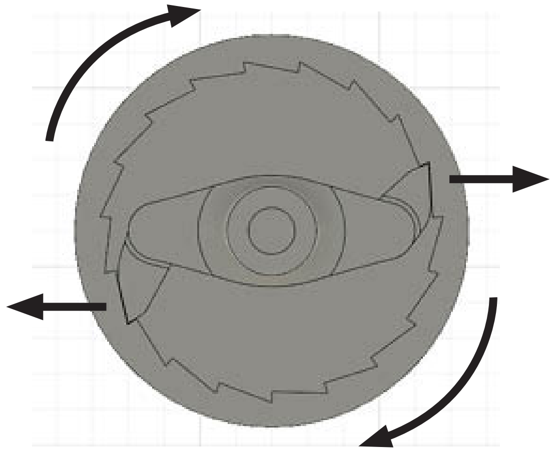


This extrusion on the back is a copy of the insert that was used by the handle of our donor product to interface with the dynamo input, allowing our ratchet to be press fitted into the dynamo.

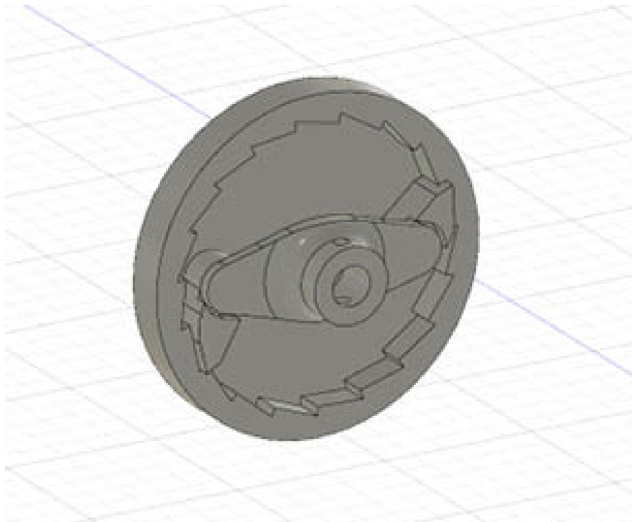
Iterations 1 to 6. The whole ratchet would be injection moulded for ease of manufacture. The arms where made thinner and the steps made smaller until iteration 6 had just 0.8mm of thickness. However, this design gave too much friction, and a new design was needed.



Instead, we designed a low friction centrifugal ratchet. The concept is simple, as the ratchet spins, the arms pivot and are thrown out by the rotational force exerted by their own weight, causing them to engage with the casing. The retraction involves the opposite, with the teeth not even touching the casing - zero friction.

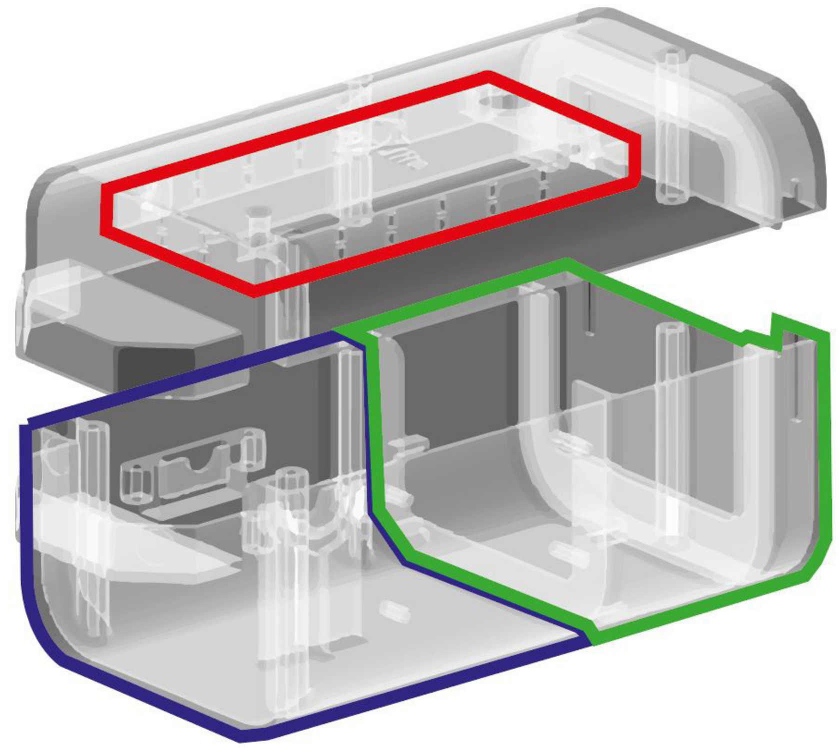


Clockwise rotation = Outward force

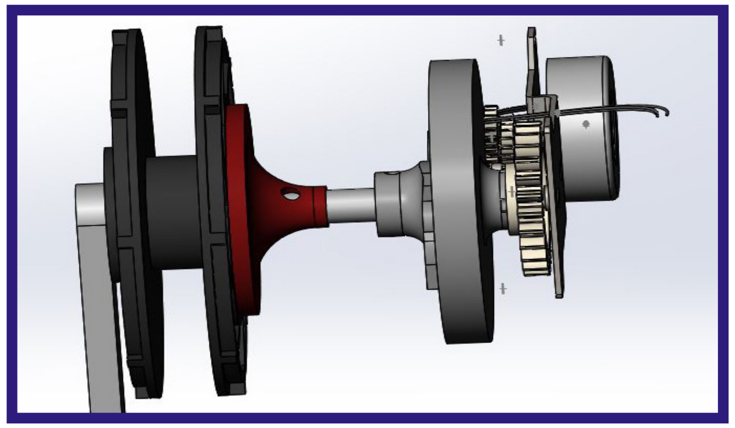


Detail design

The casing is split into 3 sections: mechanisms (blue), electronics (green), LEDs (red). The two ends of the casing are for the handles. One is fixed and only for your hand, and the other is for both hands and feet and is detachable.

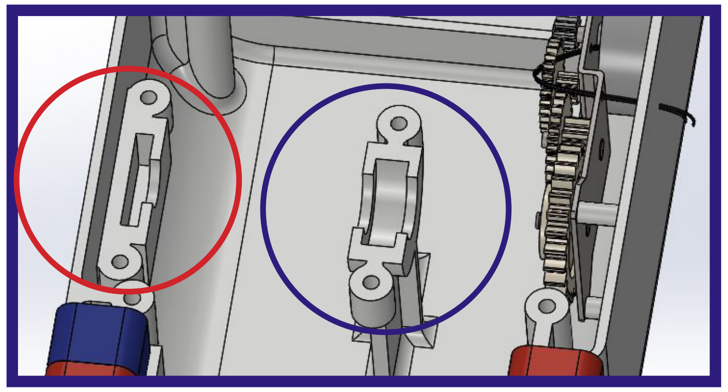


Mechanical housing

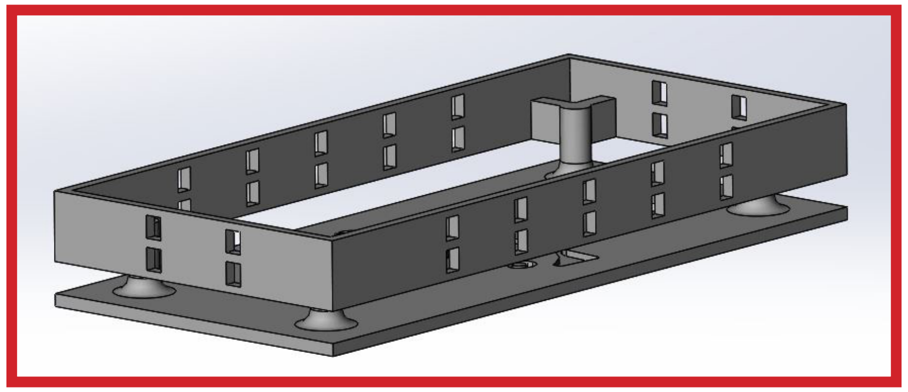


The mechanical housing constrains a torsion spring part (black) which is fixed to the main axle using the attachment part (red). This goes through a bearing (not shown) into a ratchet (grey) and finally into the dynamo for power generation.

Within the casing is 2 parts constraining the axle's movement. These are the torsion spring insert (red circle) and the bearing housing (blue circle). The axle has been made as tight as possible to minimise movement and have a more efficient power transfer.

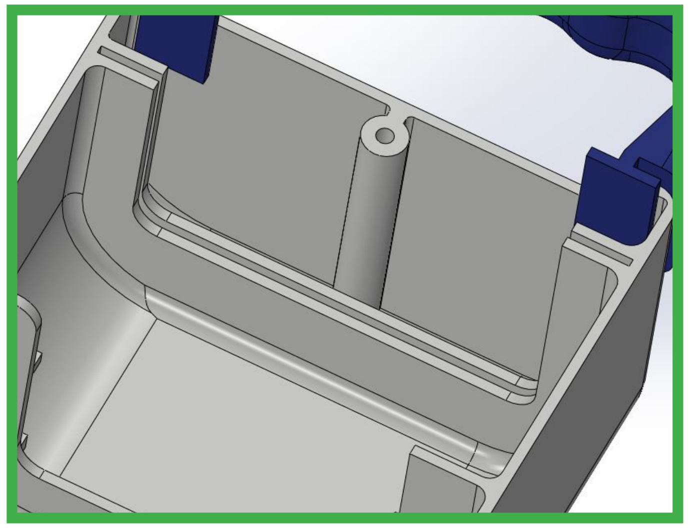


LED housing

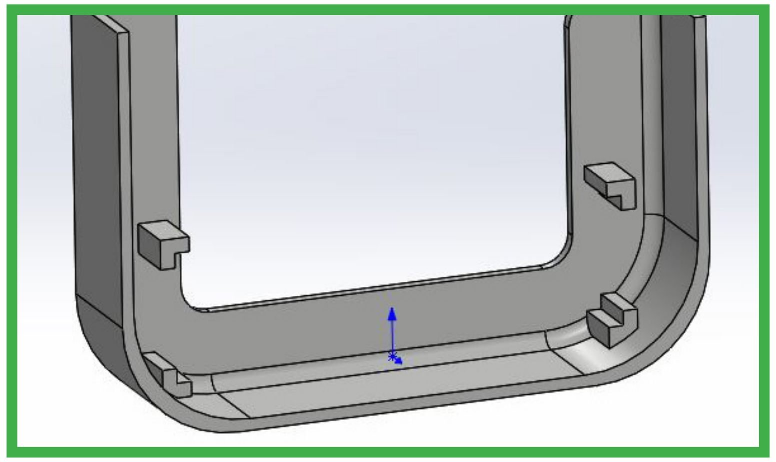


Stores up to 28 LEDs from a 3V strip LED part. Spacings between each hole have been made so that LEDs line up perfectly. As the product should glow, the LEDs face inwards, preventing a sharp light source on the edges. This way, the light will have travelled more space to get to the casing sides, inducing more dissipation for the "glowing effect".

Electrical housing



The electrical housing fixes the strip-board with the circuitry on it as well as the battery.



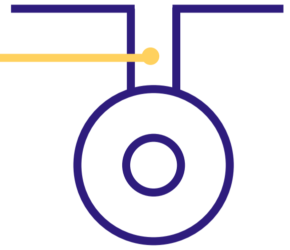
As there are only 2 components, the electronics housing is much smaller but ribs have been used to separate the mechanical and electrical housing as well as provide more strength for the casing.

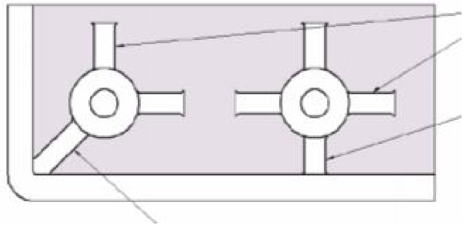
Detail design

The main part of the casing can also be injection moulded as it has been considered in the design of the product.

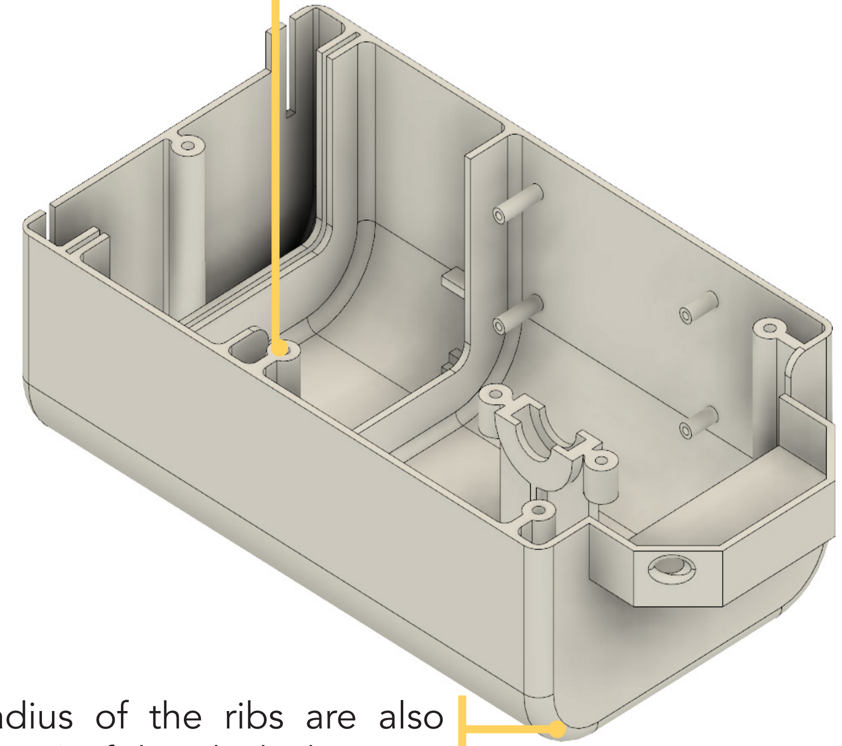
The screws used to constrain the top and bottom casing are M3 self tapping screws and therefore the size of the printed hole is 3.1mm to account for shrinkage of the material which would end up around 2.95-3 mm.

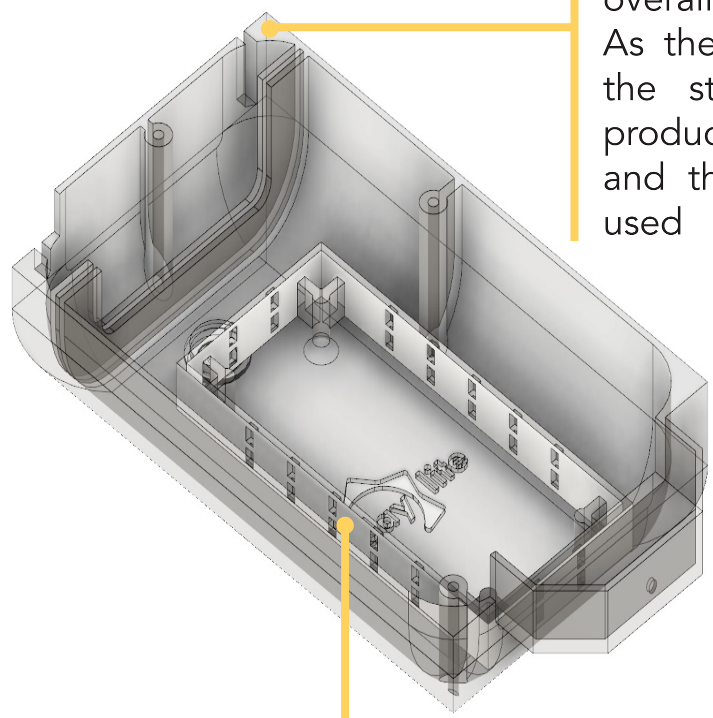
Screw holes are also joined to one side of the casing which is in turn filleted for strength.



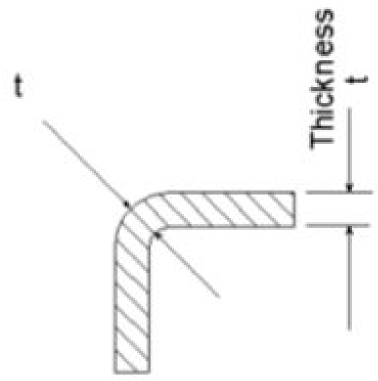


The wall thickness is a uniform as possible at 2mm. This is to aid the injection moulding's cooling time whilst still maintaining overall strength of the product. As the product is quite large, the strength throughout the product can be compromised and therefore ribs have been used



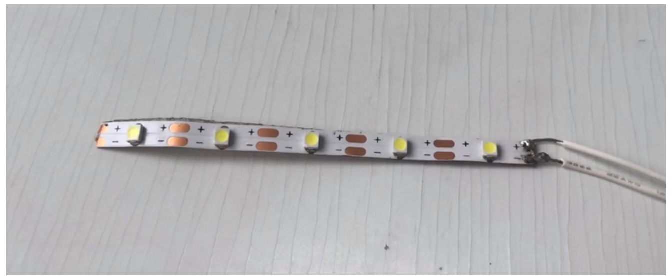


The Fillet radius of the ribs are also greater that 40% of the rib thickness to ensure there is enough strength in the product.



The external radius that has been used is beyond the suggested example but instead is a entirely curved surface of radius 20mm which would encompass up to 12.5mm wall thickness using the rule r = 0.6t + t

The LED housing includes lights which face inwards help with the dispersing of the light and a much more effective "glow" in the product. This "glow" is affected by the distance from the casing as well as the material and opacity.



An overall draft angle has been considered for the product however for 3D printing which will be the main method in producing the product, this has been excluded to aid the printing quality.

Detail design

Ratchet design

Casing design

Electronics

Assembly features

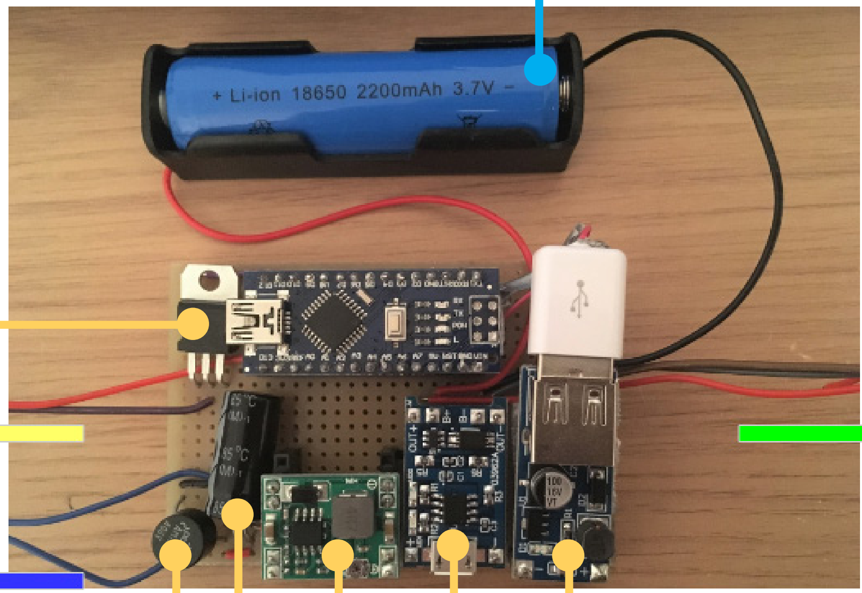
Prototype circuit

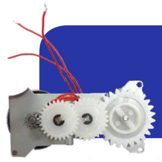
From slide 8, the circuit was soldered onto strip board which is slotted into the casing ribs. The prototype used the donor dynamo since due to time constraints, mechanisms were designed to incorporate the gear train and also the mechanical resistance provided by the gear train was closer to ideal than the stepper motor alone.

The 3 peripherals onto the strip-board are shown:

This MOSFET varies the PWM voltage into the LED strip which changes the brightness of it.

STP36NF06L N-Channel MOSFET

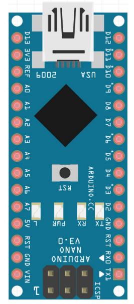




E5OD

This 5V booster is required since the output of the module is 3.7 V

Arduino



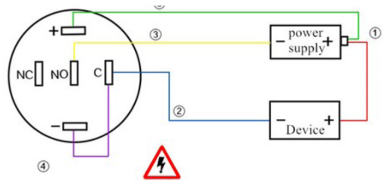
The arduino was necessary to regulate the light levels emitted to simulate real time light levels. This aligns to the user's circadian rhythm.

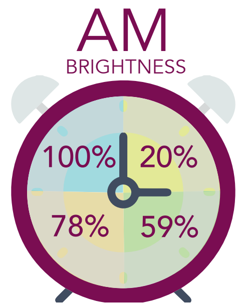
2 functions were created: **fading in and out** sequence (pulse determined by brightness change and time interval) and **constant** brightness

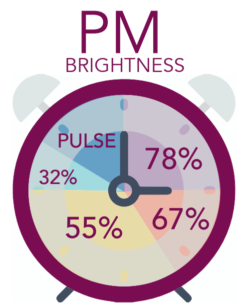
```
int pulse(int fadeamount,int interval)
```

```
int constantb(int value)
```

A latch switch was chosen for a more recognisable user interface. This therefore used 3 wires:



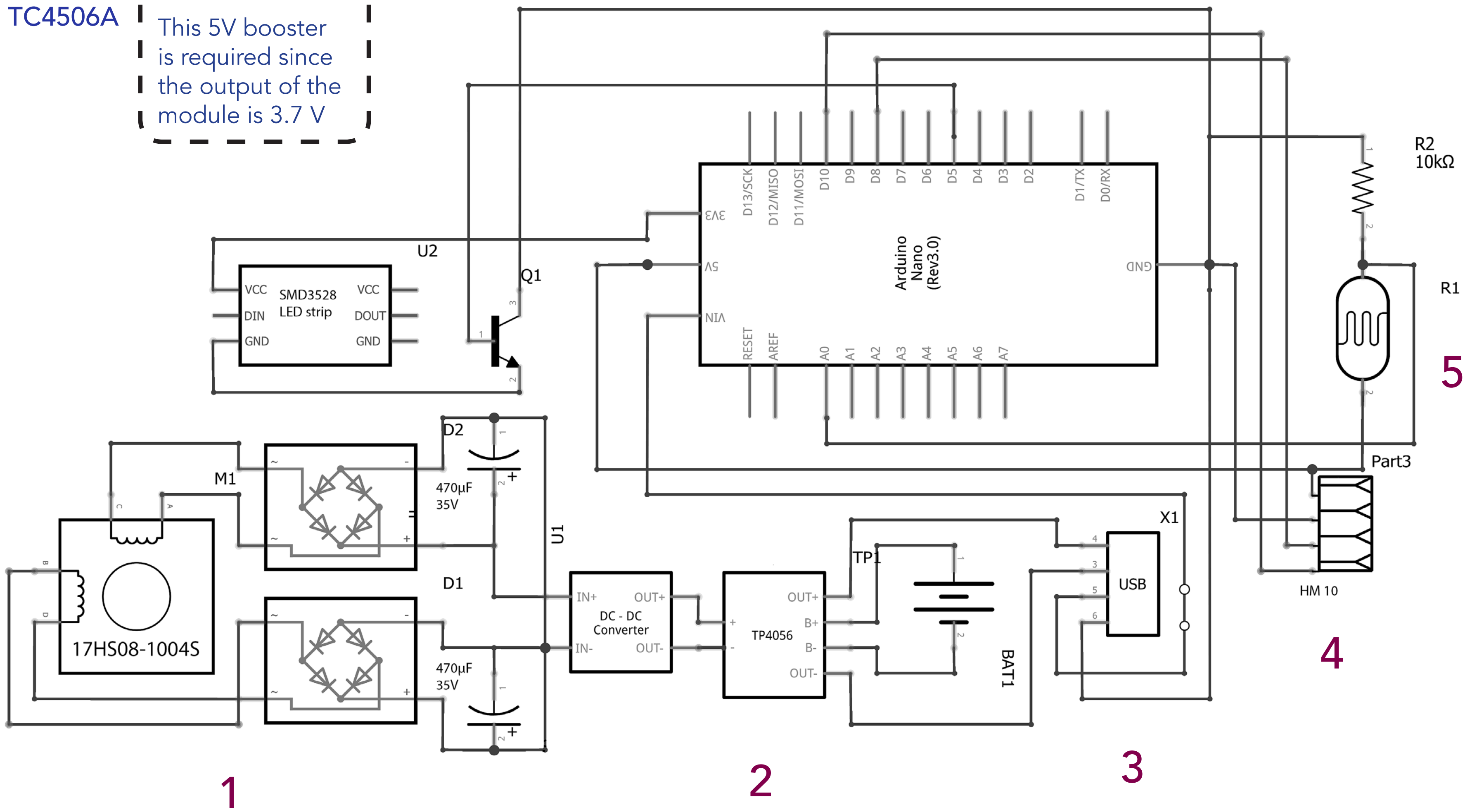




Final product schematic

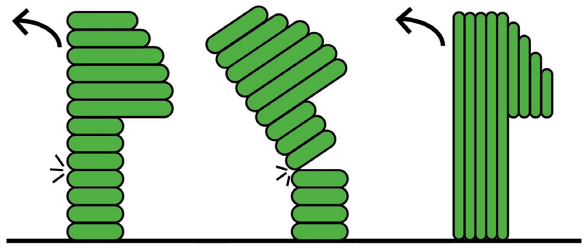
The final product will differ to include: the stepper motor, bluetooth module and a photoresistor. This would be printed onto a PCB board which would be a lot more compact in the ideal circuitry.

1. NEMA 17HS08 stepper motor will be used instead so 2 bridge rectifiers are needed for the 2 power outputs, followed by 2 capacitors
2. TC4056 charging module will take in 5V 1A and charge the battery whilst providing the load with 3.7V
3. E5OD voltage booster will provide the arduino with 5V
4. HM-10 bluetooth will be paired to mobile app to communicate statistics on stretching amount
5. Photoresistor will detect the amount of spins created by the user pulling the device and the arduino can convert this to a range of statistics (stretch time, speed) to monitor performance

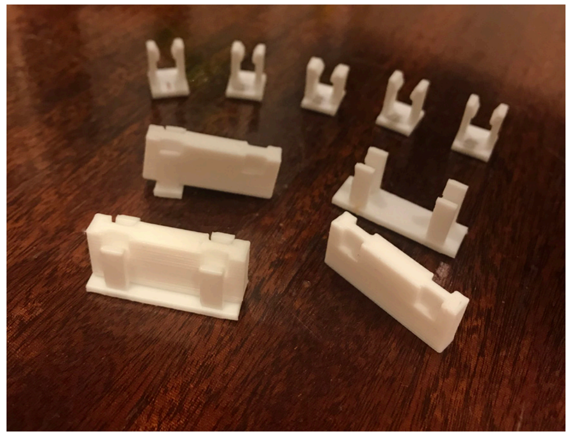


Snap fits

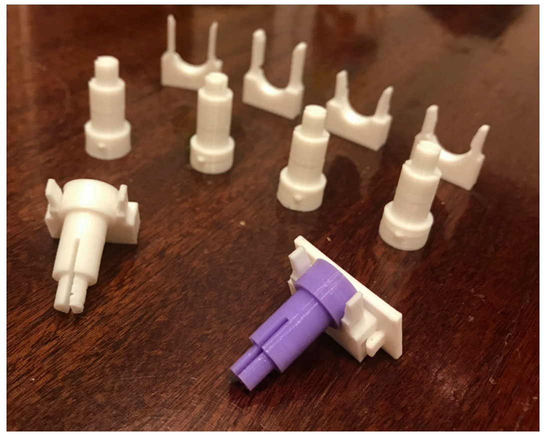
Snap fits are a good way to assemble the halves of the casing as well as components that are weak due to 3D printing limitations and allows injection moulding of overhangs.



To overcome this, many parts of the casing were initially separated and joined with snap fits. Mainly the bearing and torsion spring connector parts. Snap fits for these worked well, but were prone to wiggling as they were not perfectly toleranced. Printing snap fits also created more variations as parts do not always as exactly the measurement desired.

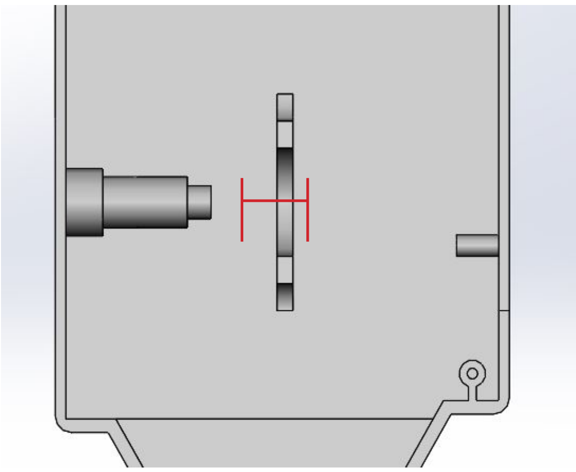


Bearing Housing



Torsion Spring Shaft Housing

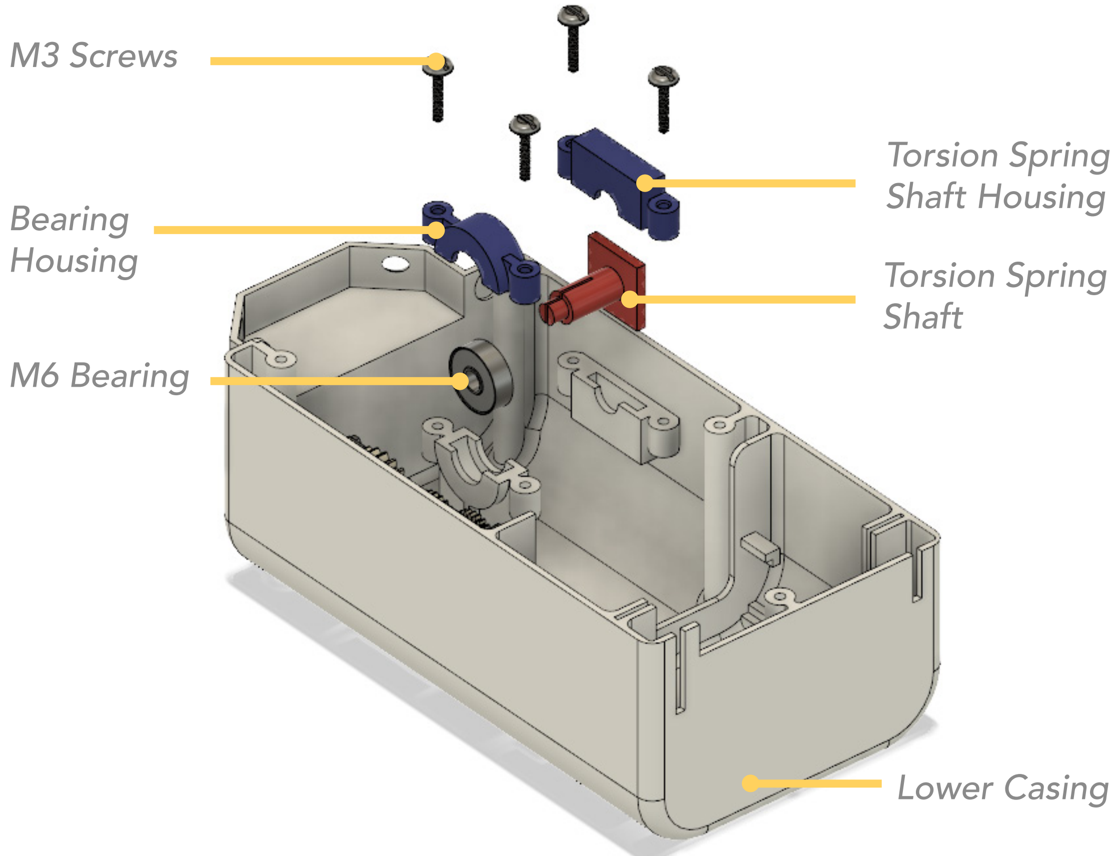
The reason for adding a snap fit for the torsion spring part is that there was insufficient space for assembly of the mechanical part of the product and having a protruding part as a snap fit would allow the entire axle to be assembled much easier.



In the CAD example, the highlighted distance in red is not enough for the torsion spring to slip through, meaning that there is no possible method to assemble the product if the parts are printed like this.

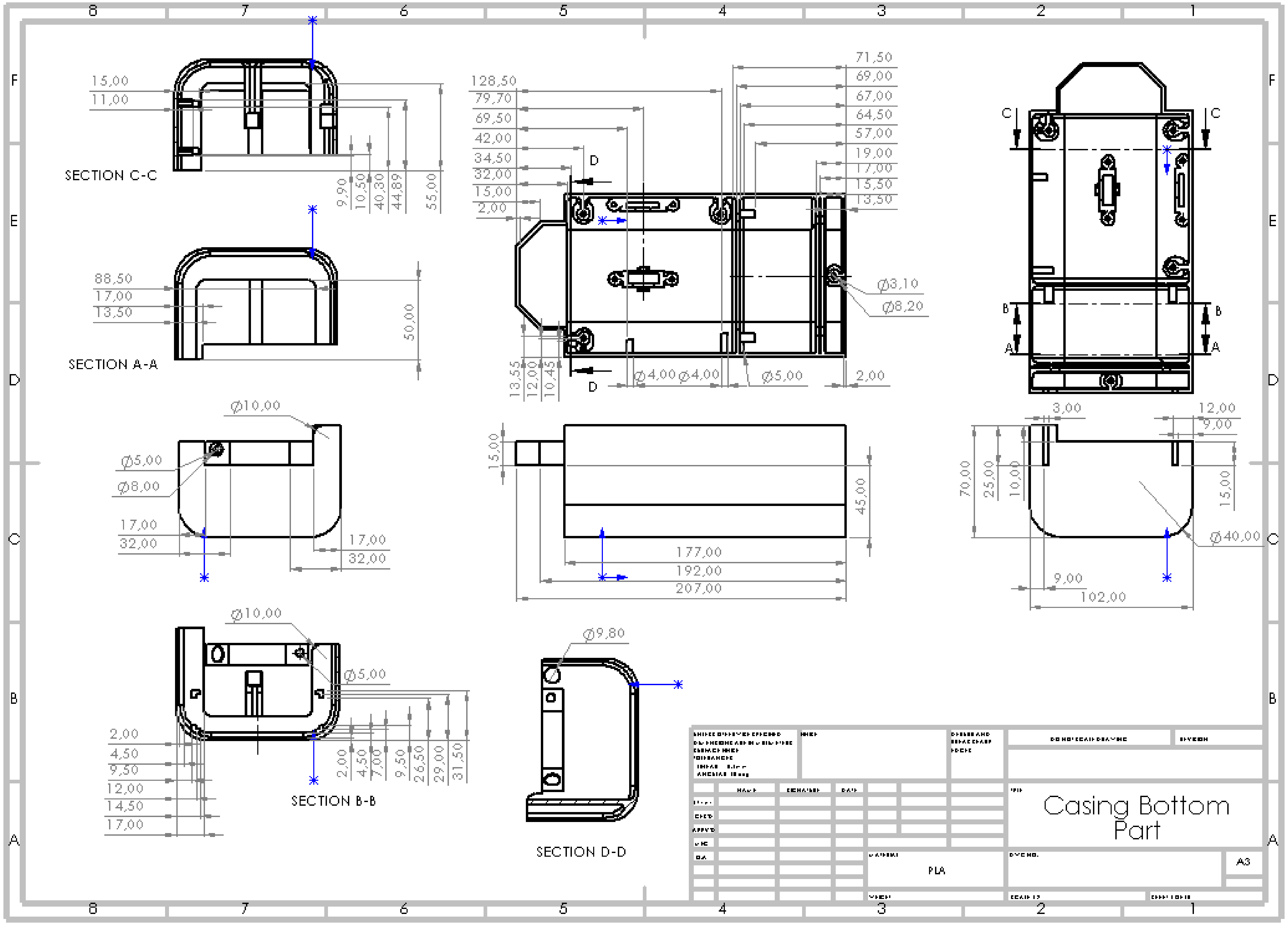
Press and screw fits

The team decided after many iterations that snap fits for such dimensionally accurate parts was not feasible. As per our outlined prototyping method, it was time to ideate and pivot. We eventually went with a combination of a tight press fit secured by a top-down part further strengthened by 2 M3 self-tapping screws.

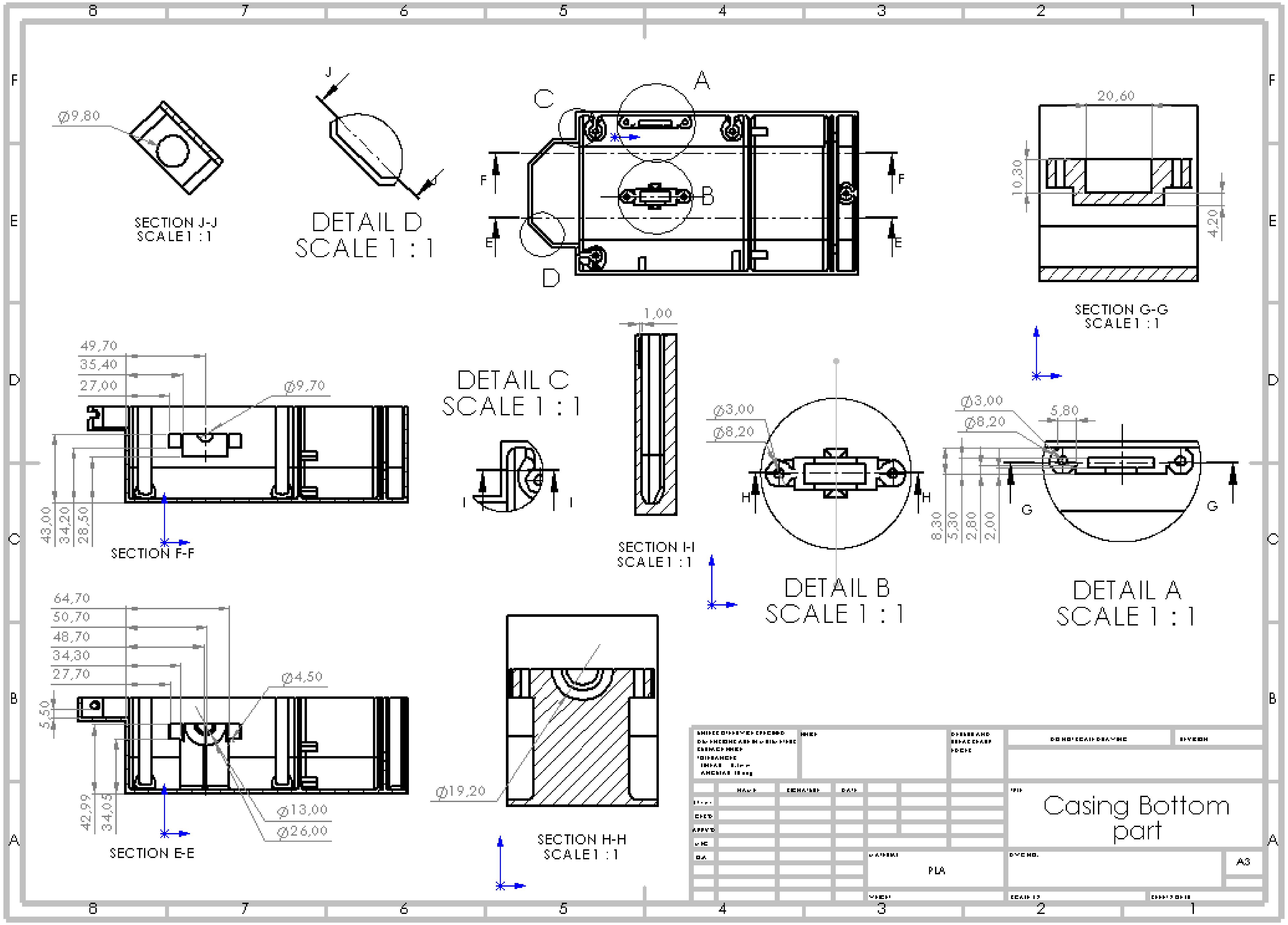


This concept was validated by 3D printing the specific part under investigation. Further to this, the dynamo holder was also printed to test 2 metrics at once. The dimensions worked perfectly first time with a 0.1mm offset to account for shrinkage enduring cooling. This made for a tight fit. This in turn succeeded in eliminating any movement in the system.

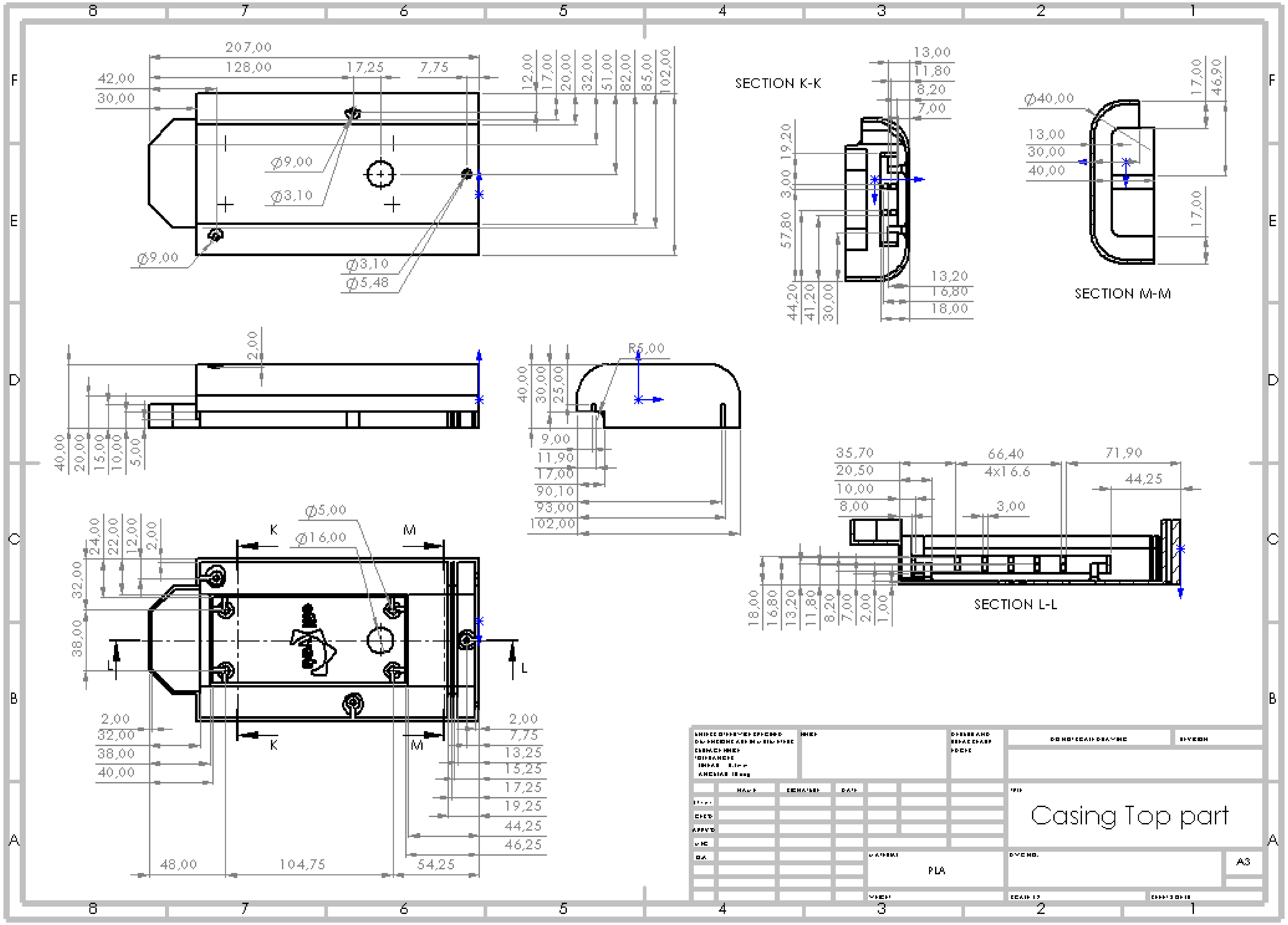
Production data package



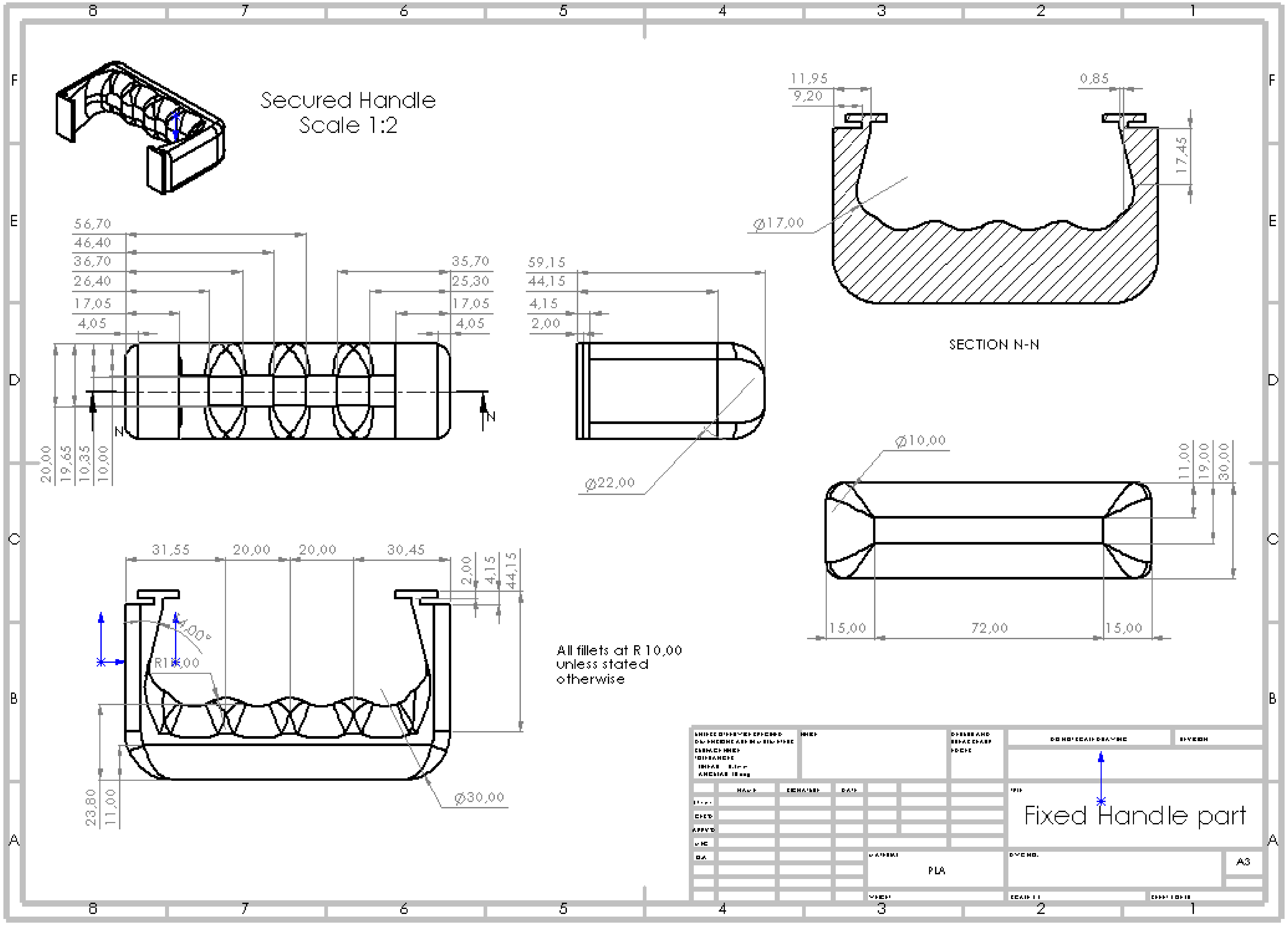
Production data package



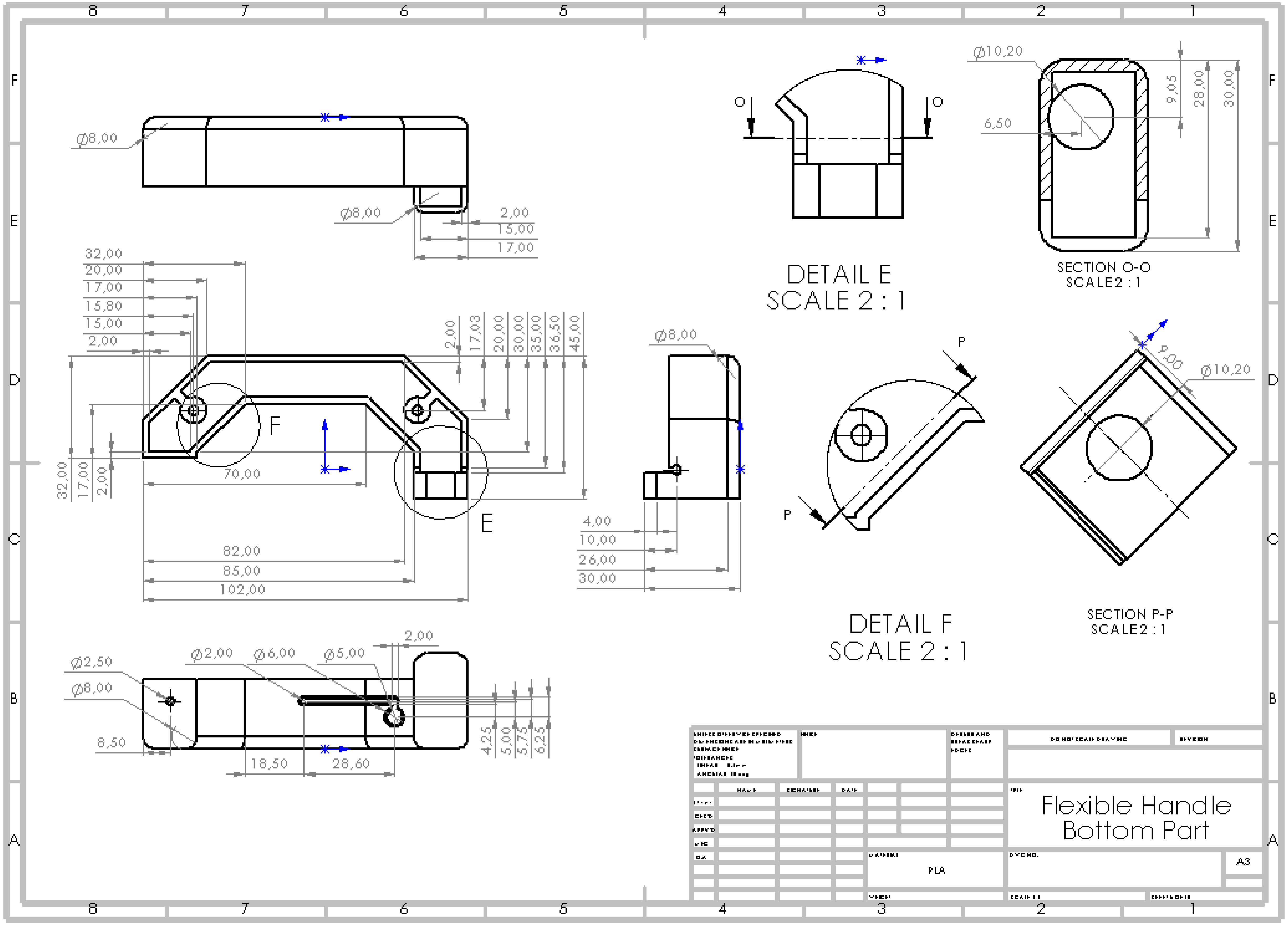
Production data package



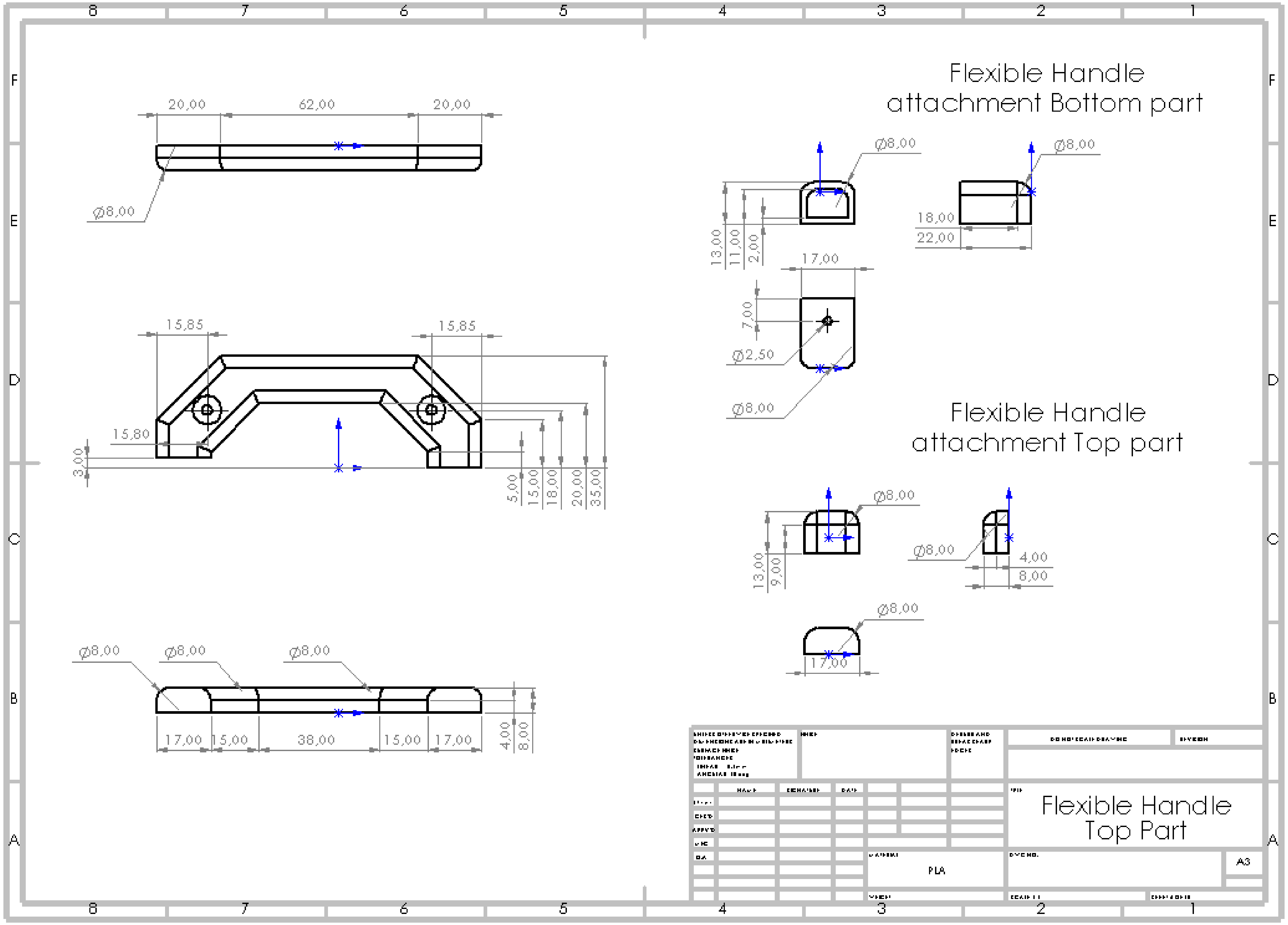
Production data package



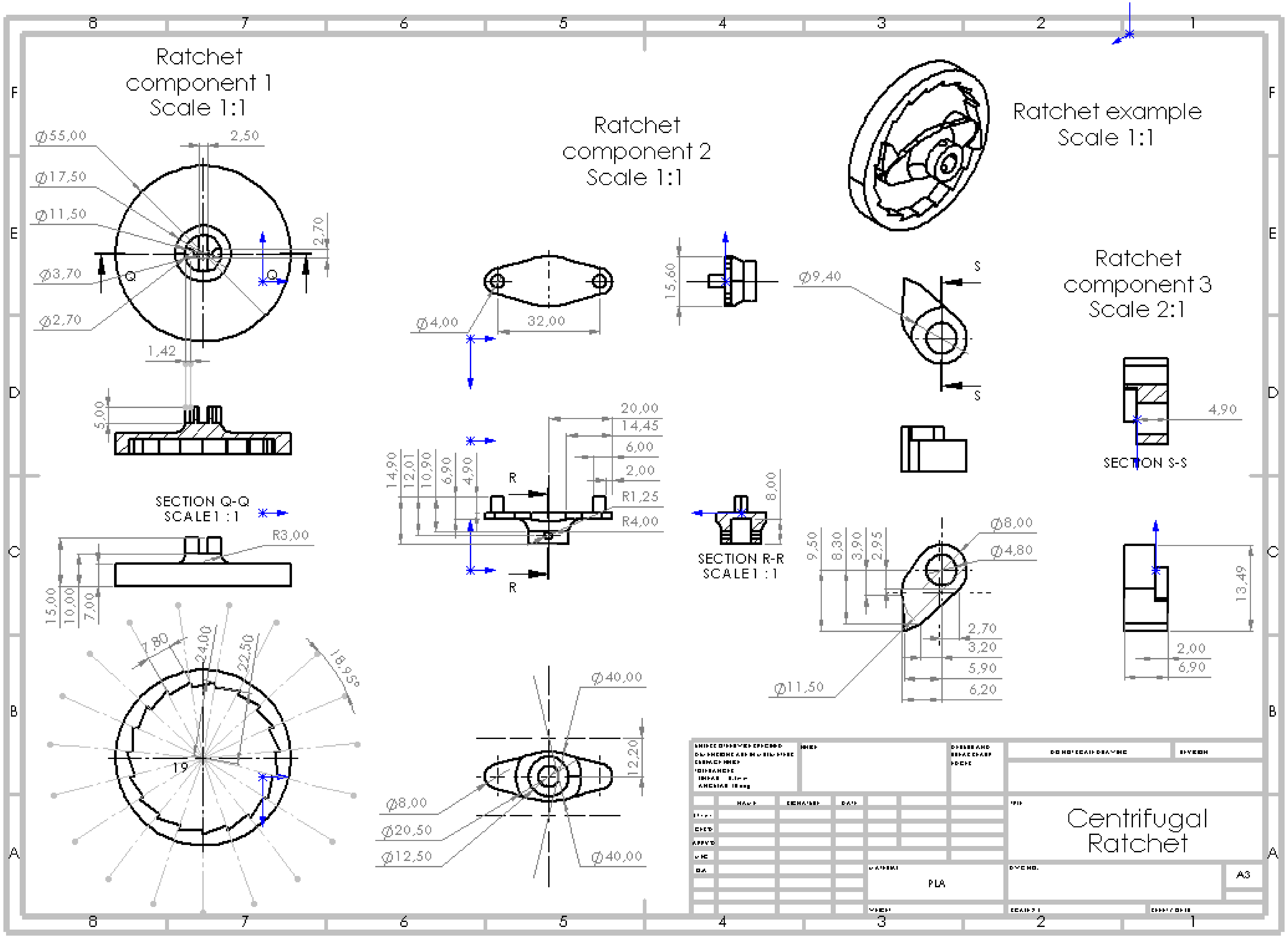
Production data package



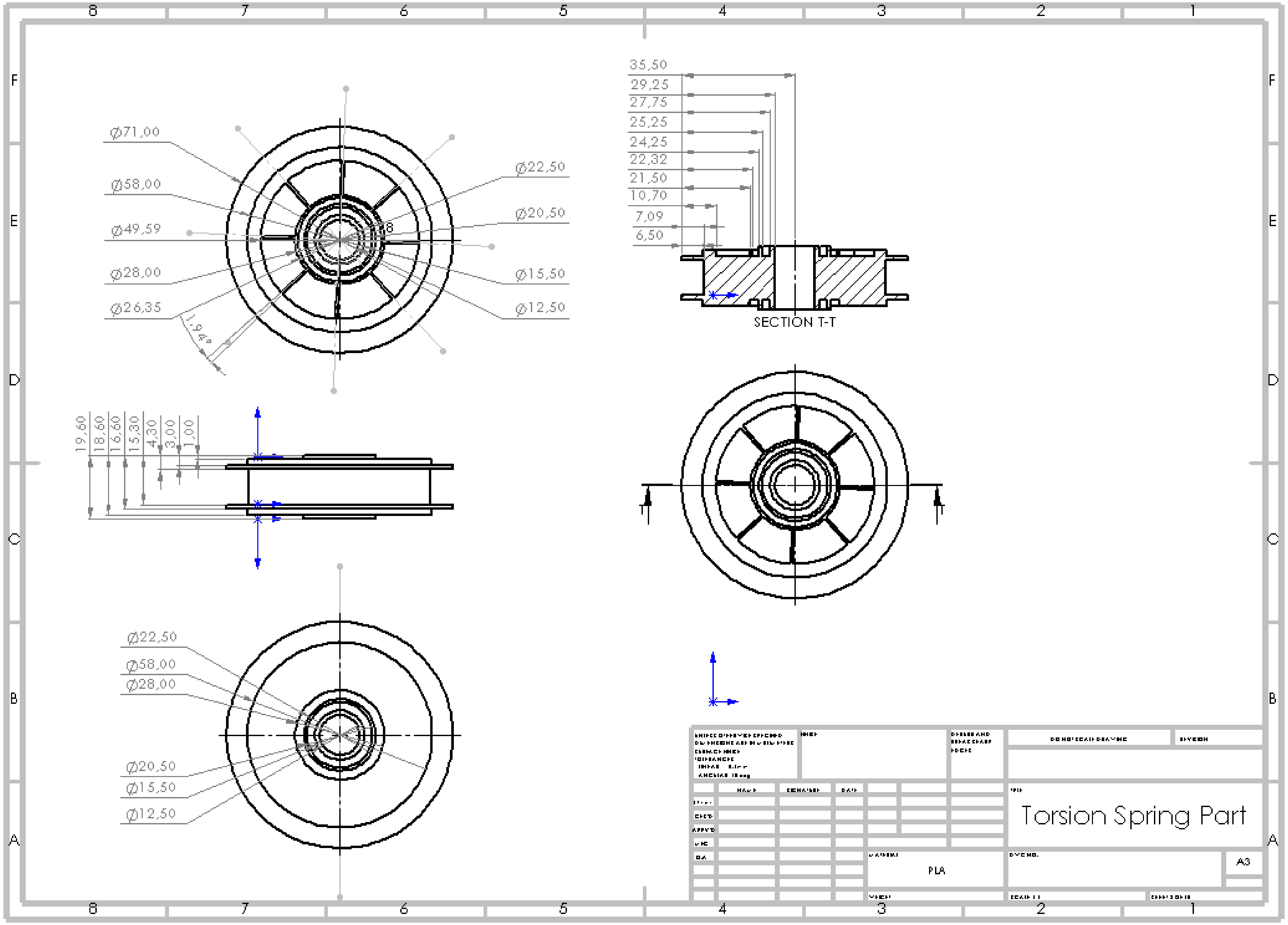
Production data package



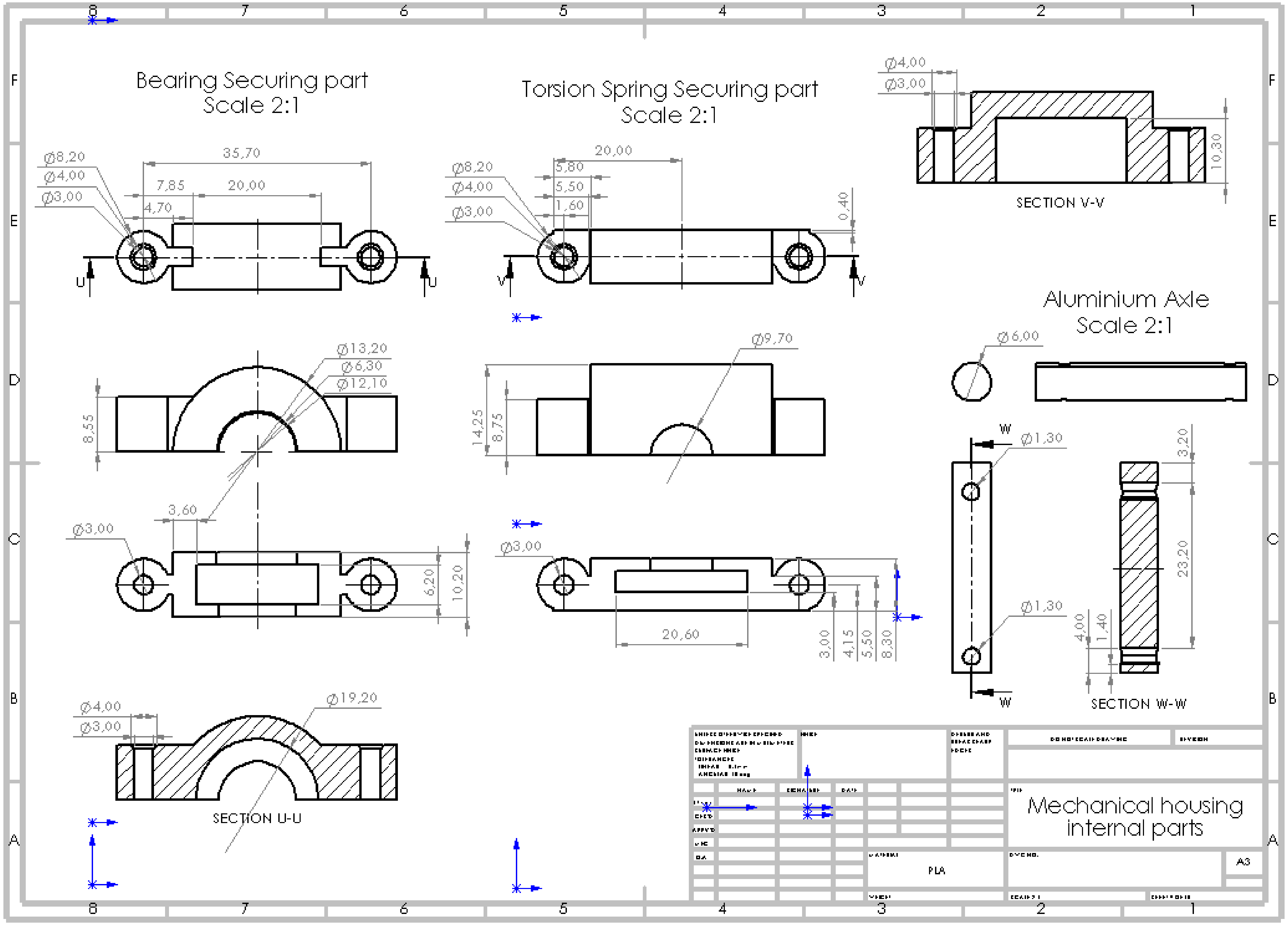
Production data package



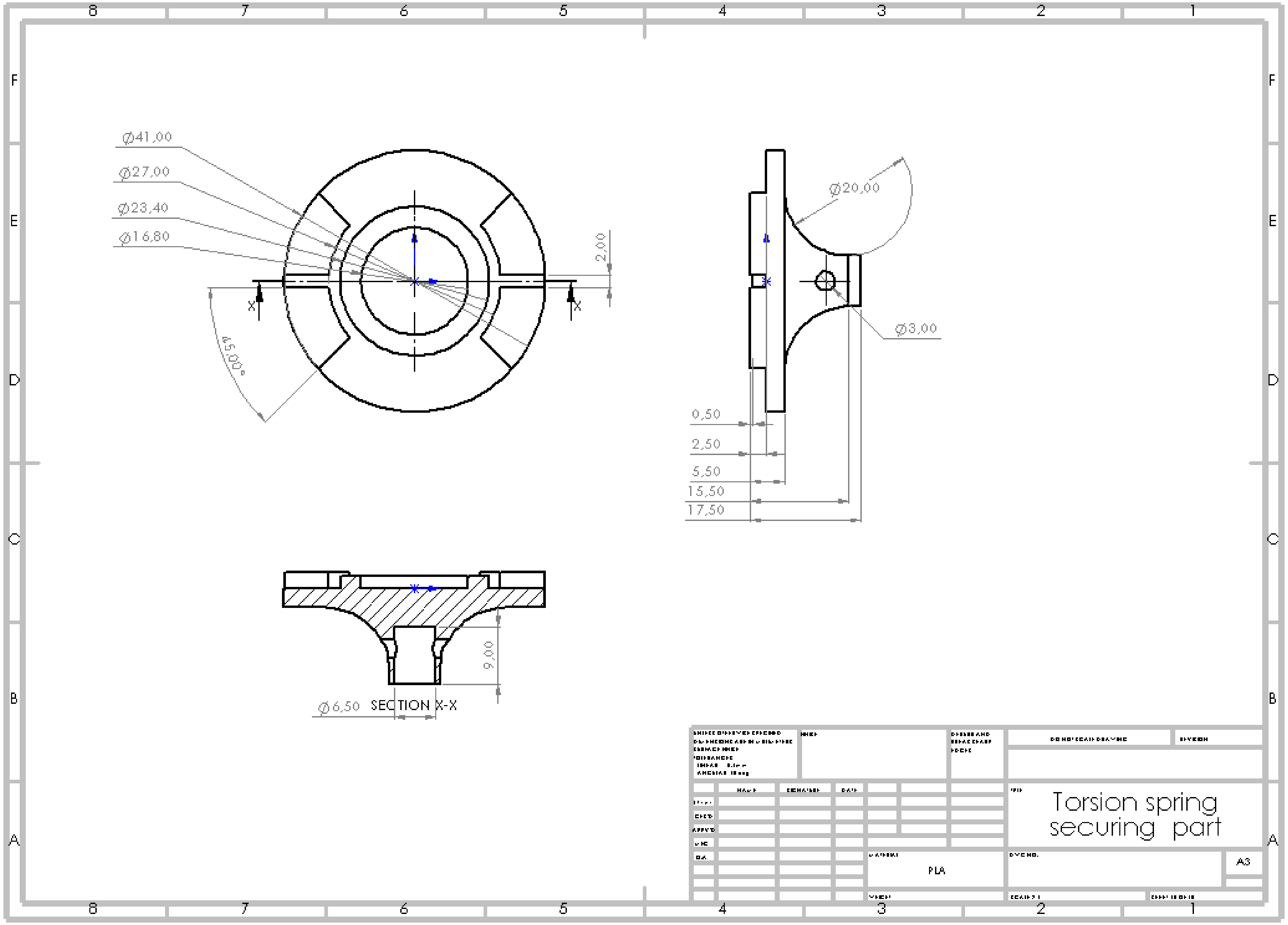
Production data package



Production data package



Production data package



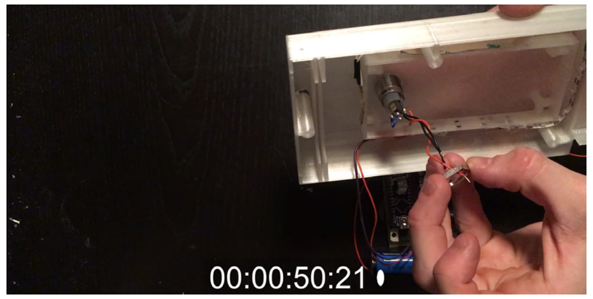
Assembly process

The assembly of Daylite is shown as steps of each process. The design was made to not use any permanent fixtures (such as super glue) as fixtures such as press fits and self tapping screws were used.

Timings

Cost estimate

1 Solder LEDs together and Press fit in LED strip



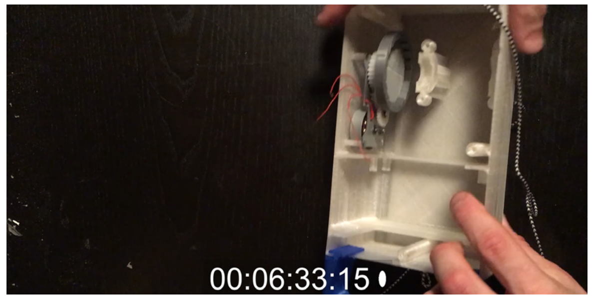
2 Screw in switch button and tighten fastening nut

3 Press fit in fixed handle by light tapping of hammer

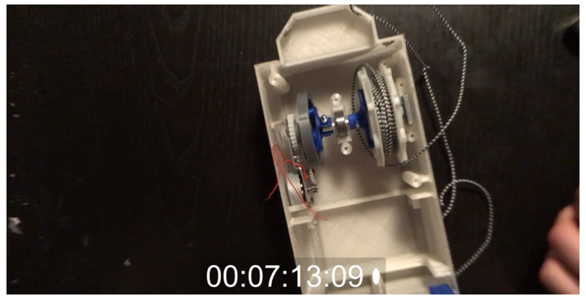
4 Thread through rope and use 2 screws to join the two halves of the detachable handle

5 Slot in torsion spring shaft connector. This is the **torsion spring assembly**

6 Attach torsion spring housing connector and pawl to shaft with grub screw. Slot bearing on shaft. This is the **shaft assembly**

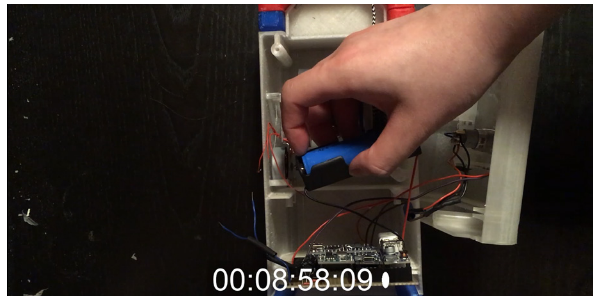


7 Press fit in ratchet enclosure into dynamo gear



8 Slot together the **shaft assembly** with **torsion assembly**, then carefully press fit into casing, tapping the bearing lightly with hammer.

9 Screw in bearing securing cap and torsion shaft securing cap with self-tapping screws.



10 Slot in circuit board and battery into ribs

11 Align top part of casing with bottom half and tap with a hammer to secure handle

12 Use 3 screws to secure the casing halves together

Link to assembly video: https://www.youtube.com/watch?v=fLY80NnC-v8

(This time would be massively reduced over time by worker specialisation and division of labour. We estimate a time of at least 4 times quicker.)

TOTAL TIME: ~12 MINUTES

Assembly process

Timings

Cost estimate

Cost per unit breakdown

Process	Amount	Price
Material	1174g	$3.80 per kg = **$4.46** (Price from: https://www.alibaba.com)
Injection moulding	16 seconds (cycle time)	$27.83 per hour = **$0.12** (Price from: https://www.sciencedirect.com/topics/engineering/processing-cost)
Sub-Assembly	92 seconds	$7 per hour = **$0.17**
Final-Assembly	124 seconds	$7 per hour = **$0.24**
Packaging	per unit	**$1.50** (estimate)
Components	4 (dynamo, torsion spring, bearing, electronics)	**$12.20** (estimate)
	Total	**$19.69 (£15.64)**

Final Retail price:

$29.99 (£23.99)

Profit Margin:

1- (($19.69/$29.99) x100) = 34.3%

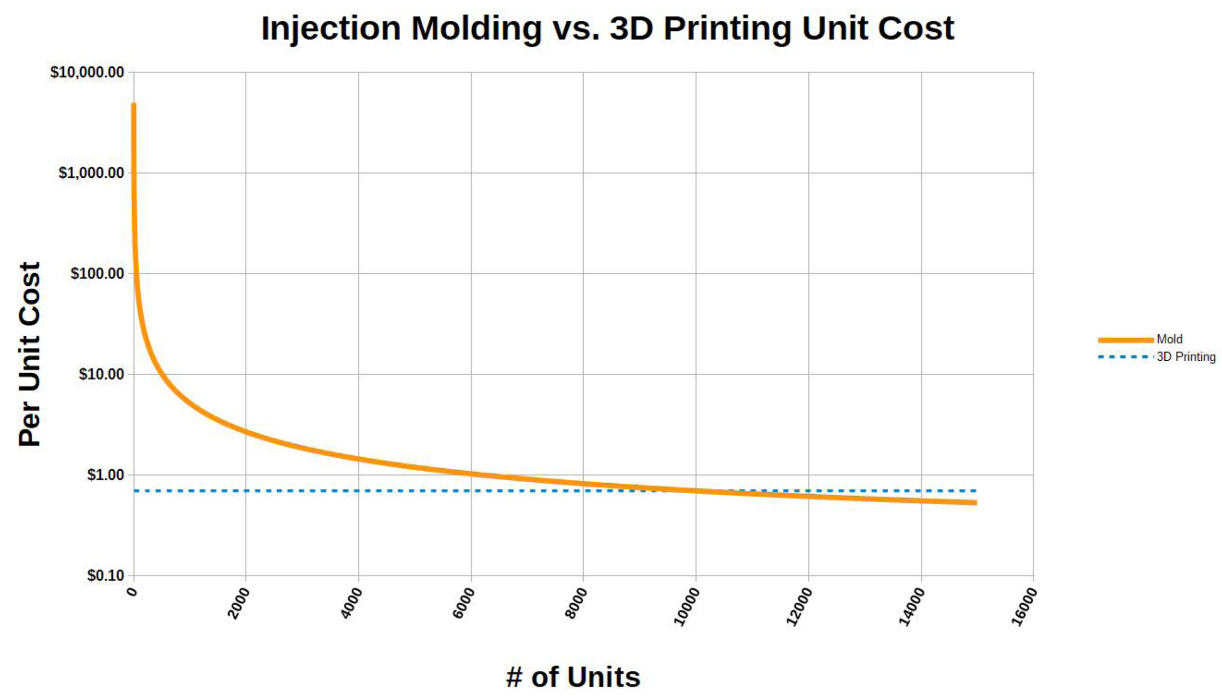
Tooling costs

Estimates for machining the mould cavity are around **£5,000 to £75,000** depending on the supplier. This cost would not be feasible for a small start up like ourselves.

Instead, the company will produce the first 1,000 units via 3D printing farms based in London. This is the number estimated by the graph below where 3D printing becomes more expensive. The profits from the sale of these 1,000 units will fund the cost of tooling.

We contacted PRODPOINT in Hackney and they gave us an estimated cost per unit of **£8.45** including material and labour to remove supports.

This would increase our COP by only **£4** - a reasonable increase to avoid initial tooling cost.



Compliance research and requirements

Which standards are applicable to DayLite?

Electromagnetic Compatibility (EMC)
General Product Safety Regulations (GPSR)

CE Marking is also required to indicate compliance with the EU legislation

EMC

The electromagnetic disturbance must not exceed the level above which radio equipment cannot operate as intended.

Its immunity to electromagnetic disturbance expected during use allows it to operate as intended.

Technical documentation shall be prepared to demonstrate evidence of compliance with the harmonised standards.

Used guidance document: here.

GPSR

It must not be placed in the market unless it is safe to use.

Consumers must be provided with enough information to allow them to know and take precautions against any risk throughout its normal use.

The address and contact details of the producer must be made available in case that they need to take action to avoid any risks.

Directive (2005): here.

CE Marking

Ensures that the product complies with the harmonised standards. The process to follow in order to obtain it is:

1. Identify applicable standards.
2. Verify product specific requirements.
3. Identify if an independent assessment is necessary.
4. Test product to check conformity.
5. Keep required technical information available.
6. EU Declaration of Conformity.

Sustainability

Waste Electronic & Electrical Equipment (WEEE)

Product must be clearly labelled as WEEE to ensure its correct disposal and treatment at its end of life.

Packaging and Packaging Waste

Identification system for materials used in packaging must be correctly followed to ensure its correct disposal.

User guide

How to install the DayLite app

Search for "DayLite" on the Google Play Store (Android) or the App Store (iOS).

Install "DayLite Tracker" on your phone and follow the instructions shown when the app is launched for the first time.

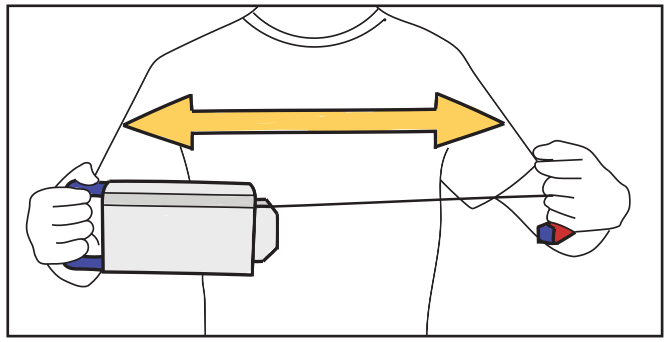
Our app has the icon shown above.

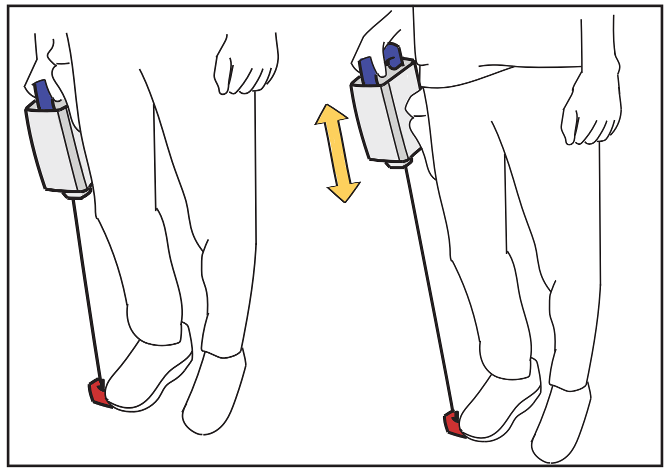
Beware of fakes and scammers! Our app should be completely free to download and should not contain in-app purchases.

What you can do with the DayLite app

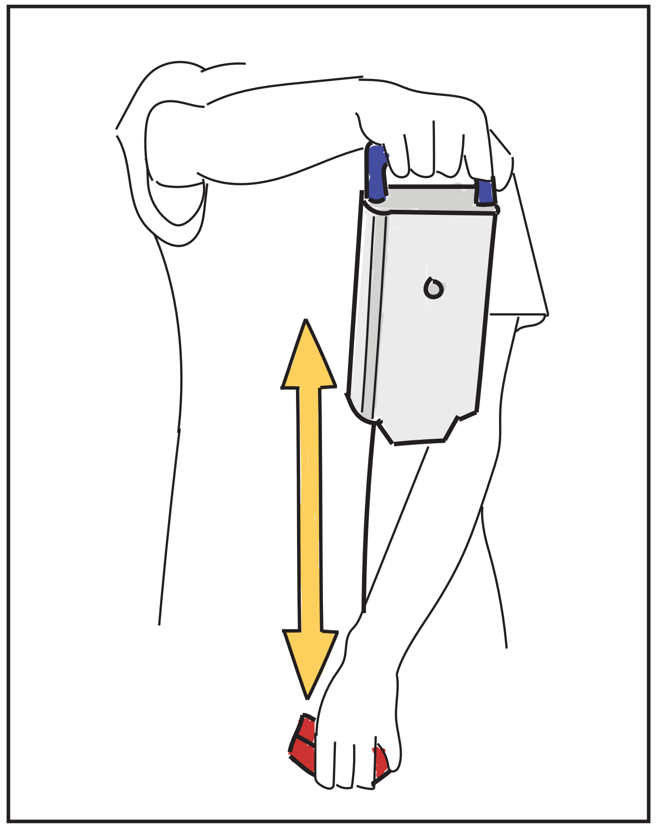
- Track your stretching sessions.
- Check how much you have charged DayLite.
- Get reminders when you have not stretched in a while to motivate yourself.

Recommended stretches





Recommended stretches

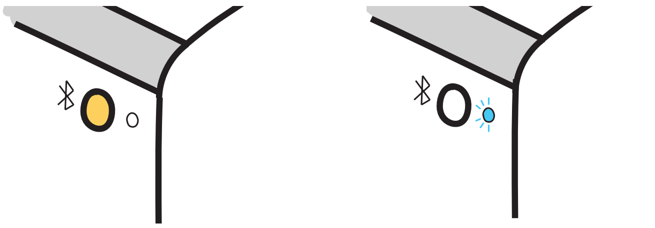


Turning the device on and off

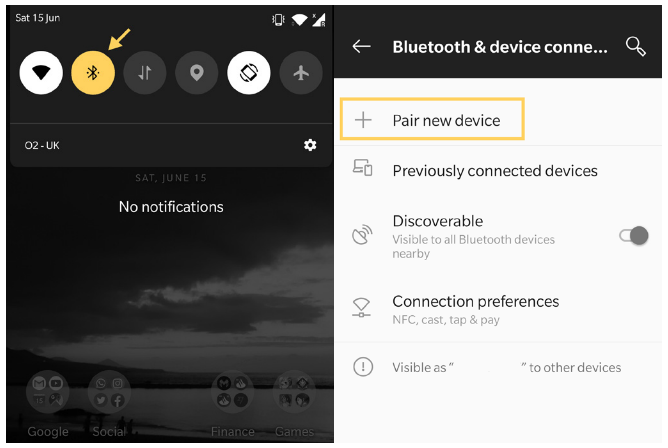
Push the power button to turn it on and off. When it is on, the power symbol turns blue.

Pairing your device

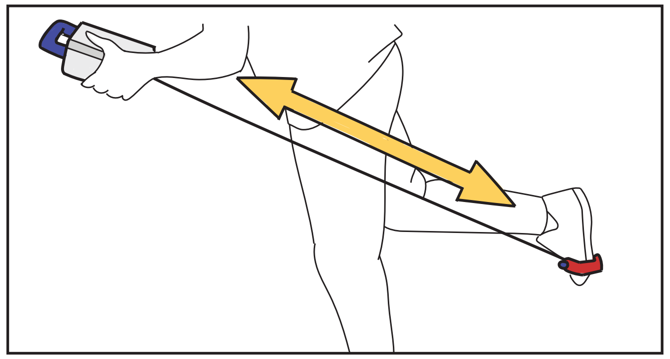
Push the *Bluetooth* button located on the side.

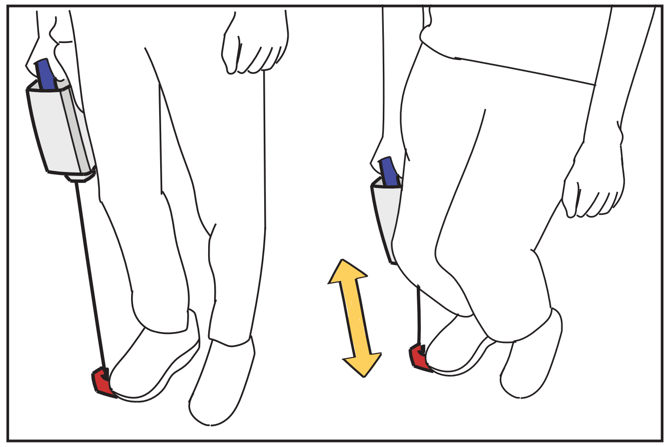


Access the *Bluetooth* settings on your phone and select "Pair new device". Select "DayLite" from the list and wait a few seconds.

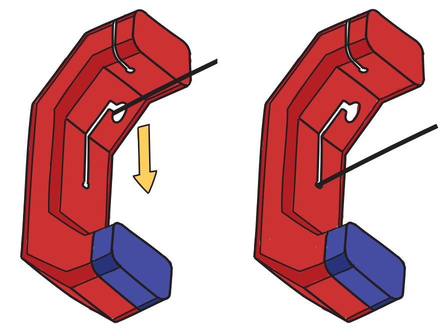


Recommended stretches

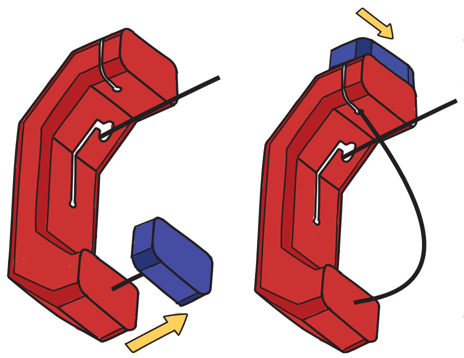




Using the handle



For better hand grip, slide the cord down to the small hole in the middle of the handle.



To use it on your foot, pull the blue tab then and slide the cord into the slot shown.

Then, loop the cord around your ankle or foot.

Precautions

Please read carefully.

Keep product away from children and pets. The cord contained in this product could become a choking or tangling hazard when used incorrectly.

If you believe that your product is faulty, please stop using it and contact customer support immediately. We will try to sort out the problem for you.

0800 123456

support@daylite.co.uk

Please do not use DayLite or the DayLite Tracker app while driving or in a position where irresponsible use could endanger your life and the lives of those around you. Our company is not responsible for accidents caused by the misuse of this product.

Materials

Protect the environment

Recent events regarding climate change have had a big impact on society. DayLite wants to contribute to a brighter future for everyone with the following promise.

Only recycled and recyclable cardboard

Our cardboard has been recycled and can be further recycled, contributing to a circular economy that reduces the amount of waste and makes the most out of our materials.

Zero plastic waste

Our packaging is fully made from cardboard and paper, with no hidden plastic linings, increasing its recyclability and aiming to reduce contamination of the oceans.

Clear identification

Following the *Packaging and Packaging Waste* EU Directive, the materials used in our packaging are clearly labelled following the numbering system established by the EU.

Production

Our packaging follows the same production process as that of a regular cardboard box.

1. Mechanical and chemical pulping of recycled cardboard
2. Production of the fluting (wavy middle layer)
3. Layers of board are pressed and glued together
4. Trimming of flaps and creases
5. Assembly and glueing of cardboard box

Packaging design

Materials Production

Compliance Graphics

Visual render

Compliance

CE Marking

Material identification

Branding

DayLite was born as a collaboration with Transport for London. Therefore, the goal was to capture the essence of the London underground while effectively communicating that of our product.

Following this idea, DayLite was given a 'tube line colour', with product features representing the stops in a tube ride towards keeping drivers physically active while regulating their circadian rhythm.

DayLite logo.

DayLite colour, representing sunlight.

London underground line representation.

Graphics

Graphics to be printed on the paper sleeve.

1. Features.

2. Brief description.

3. Logo.

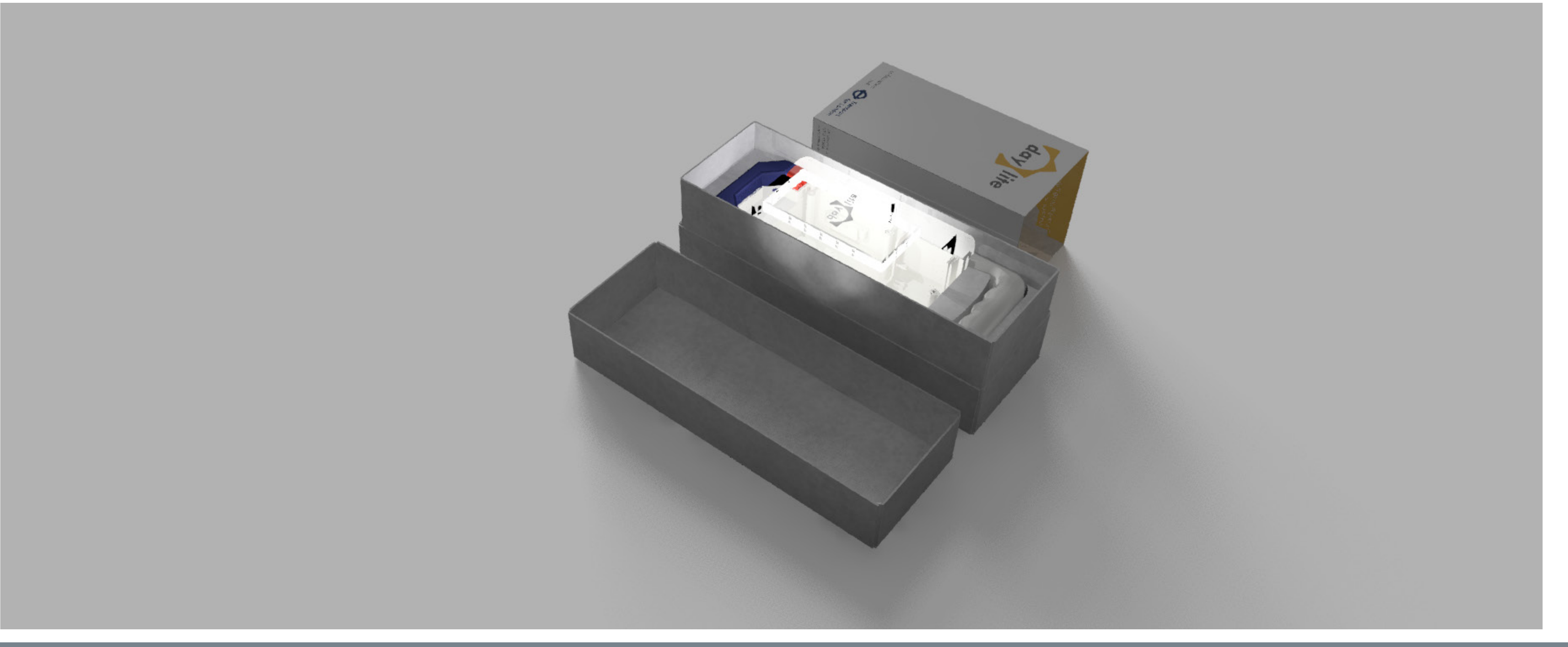
4. Customer support and markings.

Packaging design

Materials Production

Compliance Graphics

Visual render



Final design

App

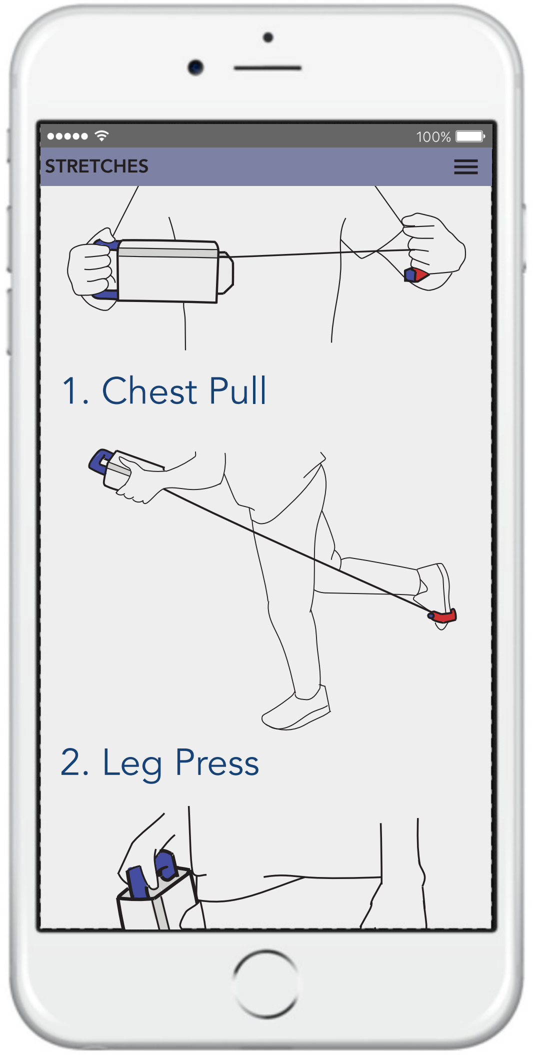
Visual render

Prototype in action

HOME

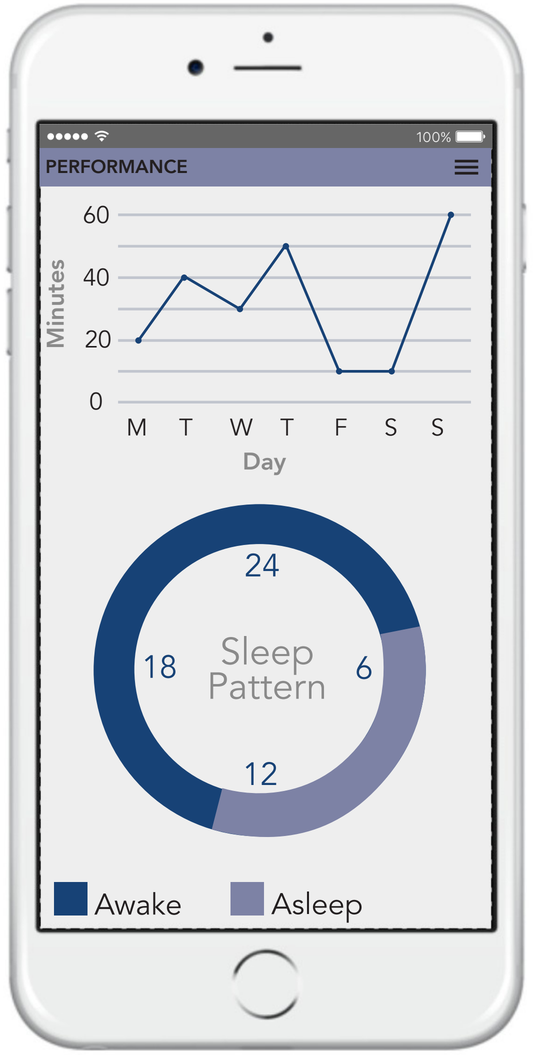
Opening page, instantly reminds user of the time and weather it is night or day. Also allows navigation to other pages. The colour scheme changes weather it is day/night.

STRETCHES



Walkthrough of the technique for the 5 main stretches that we prescribe. Tap on any stretch to reveal a video and description detailing which muscle groups are being stimulated.

PERFORMANCE



The bluetooth low energy module inside the product transmits data when the user stretches, which is plotted to show progress. The sleep pattern is presented via data from Apple Health.

REMINDERS

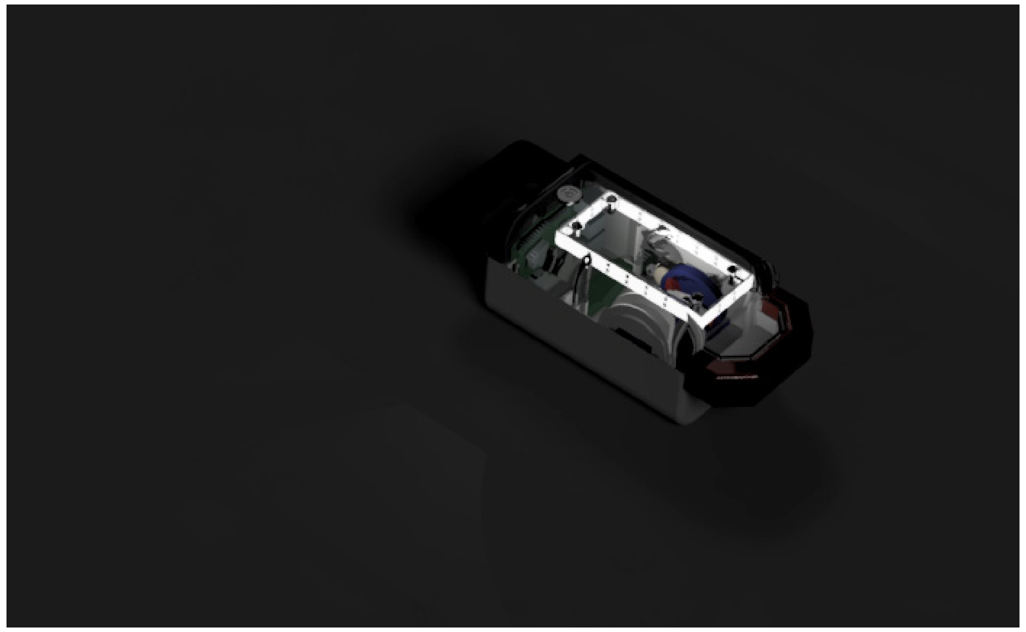
Automatic reminders are sent to the user's phone base on how recently they stretched. These can be further tailored to re-align sleeping patterns based on the aforementioned data.

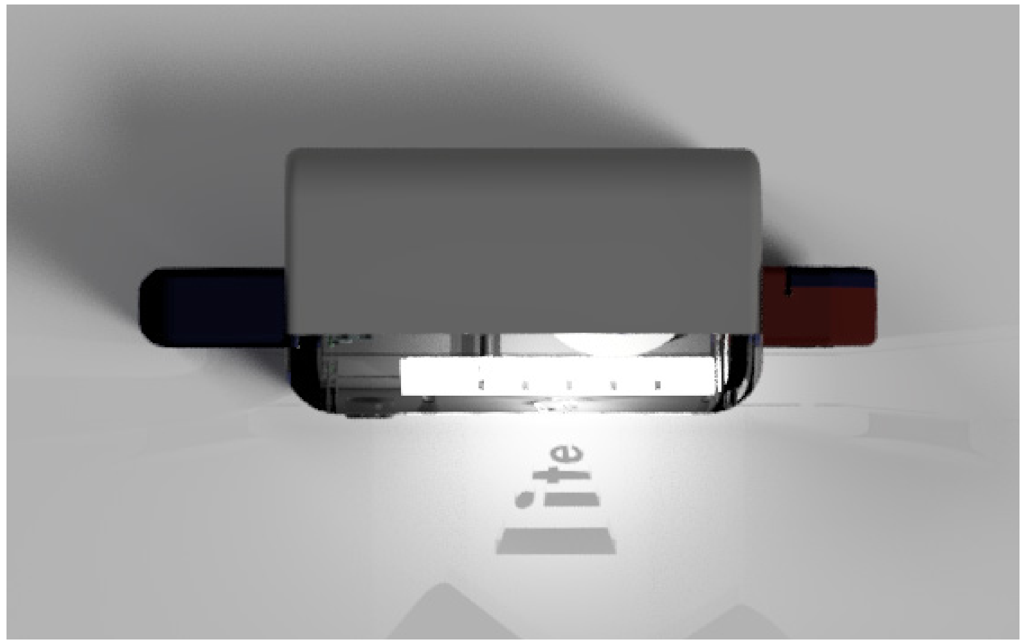
Final design

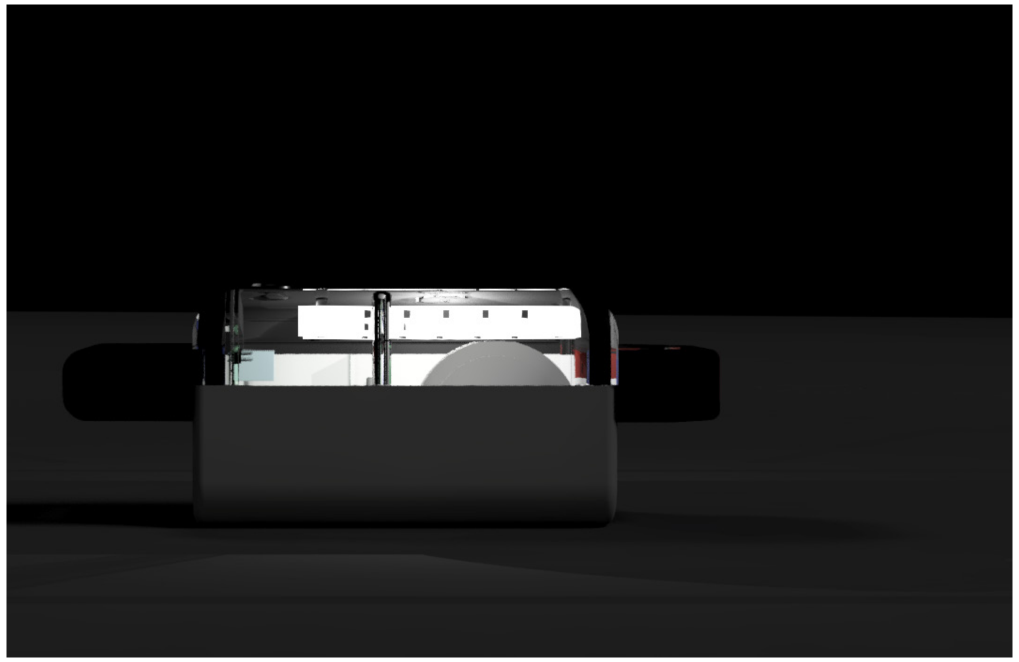
App

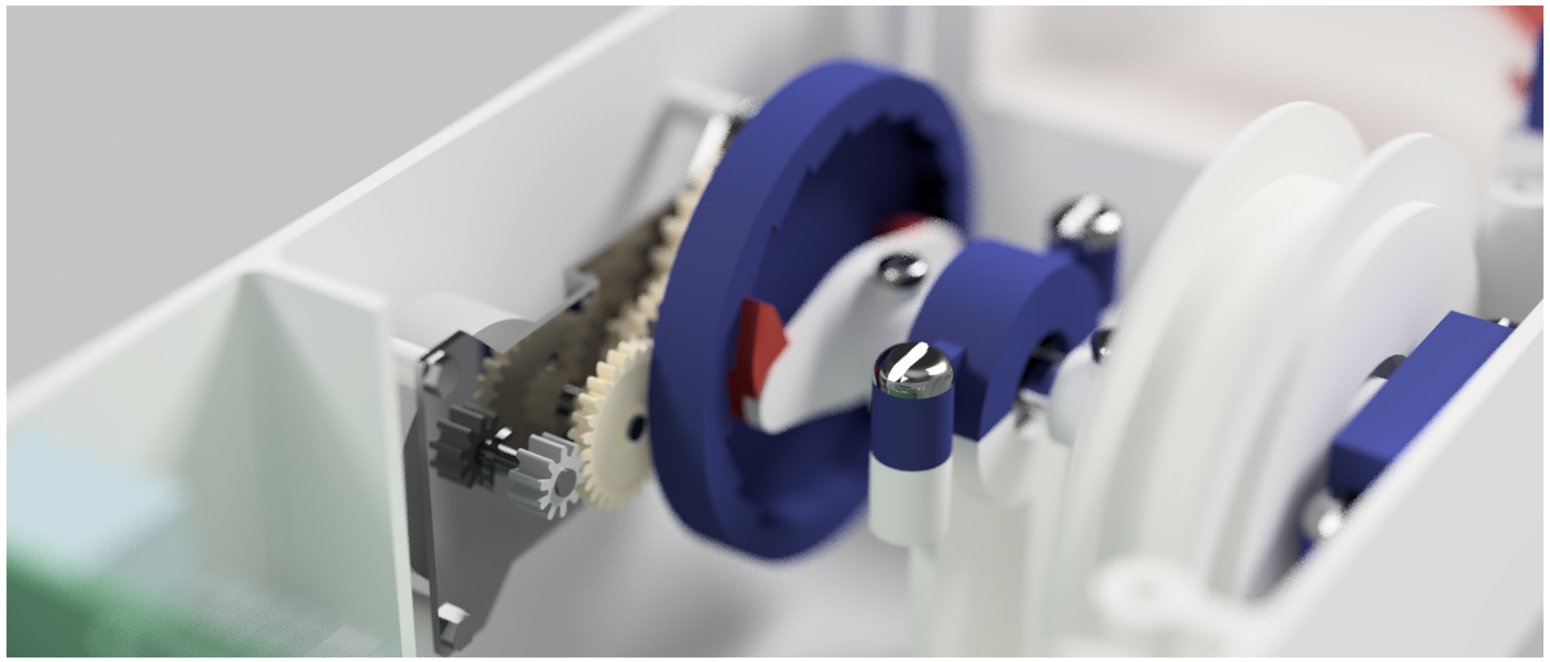
Visual render

Prototype in action







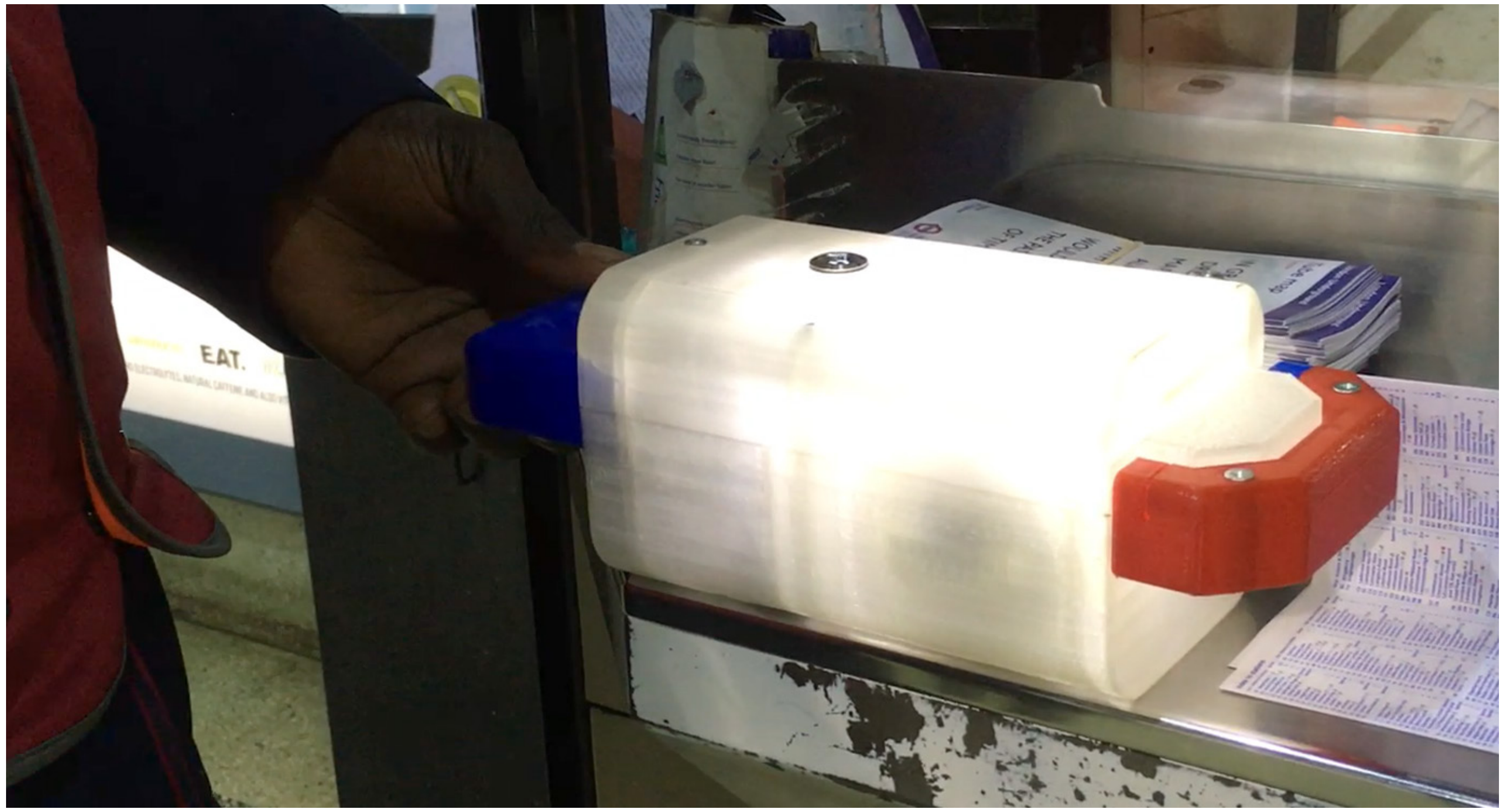


Final design

App

Visual render

Prototype in action



day lite

A portable **wellbeing** device that incentivises regular **dynamic stretching** by proportionally charging a battery that powers an ambient 'daylight' LED in a **rewarding manner** which in turn changes brightness/hue to ensure realignment of **circadian rhythms**

https://www.youtube.com/watch?v=xXqC3iBuVhY

Mass Market

If we only sold our product to TFL staff, we would limit our potential consumer pool to a few thousands. Therefore we will also target our marketing to **regular flyers** after a trial period with TFL. This market segment has very similar needs to our under-represented users, experiencing irregular sleeping patterns due to jet lag and muscle atrophy from being seated during long flights. This will allow our small business to reach a few million consumers.

Business Model Canvas

Key Partners

- An early partnership with TFL to ensure product is in line with **regulations** and ensuring it does not distract the driver, and perhaps TFL would supply our product themselves if they consider the product as a **wellbeing booster**.
- Contact with the **UK Civil Aviation Authority** abut making our product safe for use on flights.
- Acquisition of Component manufacture over time, including printing our own circuit board, dynamo manufacture, torsion spring manufacture etc.

Key Activities

- **Production** of our main product at a low cost.
- Directed **marketing** to our customer segments.
- Regular product updates and brand strengthening activities such as strong customer service.
- Sale through **online stores** such as Amazon.

Key Resources

- Secure early intellectual property by **trademarking** name and **patenting** product.
- Secure funding through **Kickstarter** and contact potential investors (TFL)
- Require production facilities, a small workshop at first expanding into a factory in long term.

Value Propositions

- The ability to prevent **muscle atrophy** and **misaligned circadian rhythms** through a device that incentivises regular **dynamic stretching** by proportionally charging a battery that powers an ambient 'daylight' LED in a **rewarding manner**. In turn, this light output is delivered by an Arduino which adjusts the brightness and hue based on time of day.
- This opportunity has been identified and justified by thorough **user research** and user testing.

Customer Relationships

- Relationship is based mainly on the product itself and the app that accompanies.
- Easy to navigate technical help and warranty with free repairs if product fails to ensure a brand image of **quality assurance**.

Channels

- Initial Kickstarter page to raise awareness, then targeted **Facebook/Instagram ads** to users fitting out customer segment. Get an early bank of good reviews from user trials to act as a proof of concept to other users.
- **Online retail** will be used for sales through our own website and Amazon

Customer Segments

- **TFL train drivers** working in the dark (underground or at night) at first.
- Then, further expansion when the initial market has been saturated to **frequent flyers**. Mostly businessmen that are constantly flying to get to meetings around the world, or perhaps travellers who take many flights to go on holiday.
- Further to this, anyone who is sat for long periods of time and suffers from lack of sleep: **office workers**, security guards etc.

Cost Structure

- We will be **value driven** at first, not making much profit to build the brand image and a strong consumer base from our under-represented market segment.
- In the long term however, we will need to be **cost driven** in order to compete and profit. **Fixed costs** will include: injection moulding dies, rent, marketing budget. Avoiding the high start up cost of injection moulding by 3D printing the first 1000 units. **Variable costs** will include: salaries, materials, shipping.

Revenue Streams

- **Individual Sales** - Our customers are willing to pay for a healthier lifestyle after we provide evidence that long periods of sitting in darkness has adverse affects on physical and mental health - most of our customer segment **do not** own a solution to this yet.
- Further revenue could come from **industry partnerships** with TFL/Airline companies should they want to provide the product themselves e.g. British Airways complimentary gift to first class passengers.

Commercial positioning

Business model

Porter's five forces

We have engineered, designed, and optimised a product that is ready for market, now we have to ensure that it will be a profitable entrepreneurial endeavour. We will use Porter's Five Forces to assess the attractiveness and profitability of this Industry and market segment.

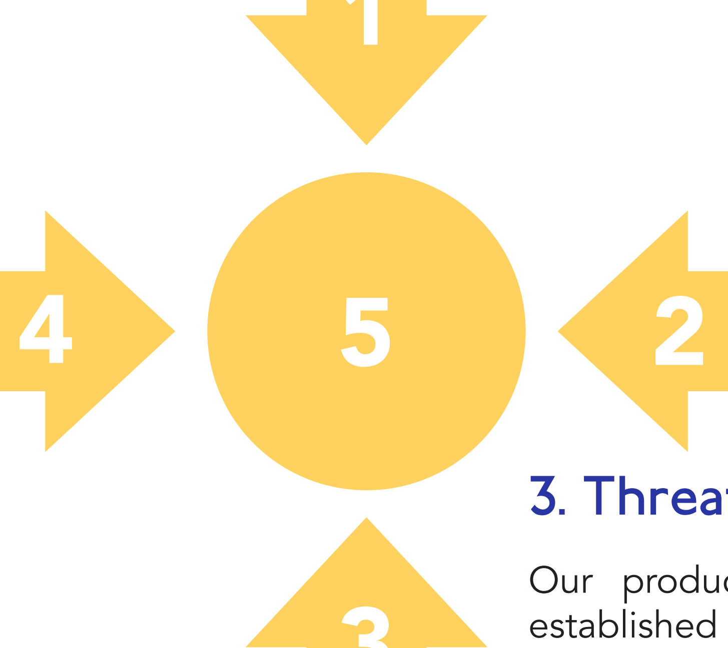
KEY
- \+ Force in Favour
- − Force Against
- ○ Neutral

1. Threat of New Entry (○)

During the trial period with TFL, there would be very low threat of entry due to the tight regulations of government organisations. However, the mass market would be completely free market with very low barriers to entry - we will therefore need to create a strong brand image to create loyal customers

2. Buyer Power (+)

The number of buyers is relatively small with a few million only buying 1 product at a time. Due to the unique nature of our product, the buyer doesn't have much power as there are few similar alternatives on the market.



Industry:
Travel Accessories

Market Segment:
Frequent Flyers

5. Competitive Rivalry (−)

Competition in the frequent flyers market segment is high due to an existence of disposable income of those who fly often as it is inherently expensive. Therefore there are many companies trying to solve the problems of these users as they can afford expensive gadgets and items. The benefit from our product doesn't require much learning and is susceptible to switching to competitors - therefore we will aim to hold our customers by creating a strong brand image and regularly updating incentives such as attachments/add-ons which improve the overall experience or expanding the suite of similar products.

3. Threat of Substitution (−)

Our product could possibly be replaced by already established habits/rituals that frequent flyers engage in to deal with jet lag and muscle atrophy. This is a threat to our profitability and needs to be addressed in the long run by providing a strong incentive why our product improves their current situation.

4. Supplier Power (+)

We use fairly basic components: torsion spring, dynamo, Arduino, M6 bearing etc. This makes it highly unlikely that any of our suppliers will drastically increase their prices as they would lose prices competitivity in their respective markets. Furthermore, there are many different suppliers for us to choose from. Thus our cost of production will remain constant.

Project plan

TFL validation

Milestones Updates

Once the product was manufactured, we sought advice from TFL through a staff network meeting. We met up with Matt Davis (pictured below) who is the Chair of the staff network group for disability. His role is to represent the development of schemes to make TFL a more accessible organisation for staff members in particular

Chair of staff disability

London Underground staff

Product approval

- Very unlikely to be a distraction in the cab
- Can be used within driver breaks
- Previous TFL active schemes to improve driver well-being (SCN schemes). They have included: healthy eating, exercising, stress courses, and even playing soothing music inside the cab. However Matt explains the limitations as these require driver's own initiative as they are done in out-of-work time. This is why using this device in breaks could be more promising
- Business validation - Matt was confident that at a price of £23.99 we would be able to sell via TFL. He also suggested a possible renting system where TFL gains further incentive to push our product.

Main critique points

Size: Drivers have large bag but size still too large and obtrusive. This prototype uses a donor product of the cord reel with the torsion spring inside which accounted for more space. During procurement, this part can be made more space efficient.

Ergonomics: The hold of the fixed handle was approved of, however the moveable handle was not as comfortable to the user. Adjustability needs to be considered as workers range in size.

Incentive: The charging light is a direct motivation of the device. However long term incentive is needed for it to be adopted for a longer time. The performance monitoring app will address this, however there needs to be more thought into this.

Planned meetings and next steps

Meeting with Wellment: Sub-organisation within TFL disability group that focuses solely on mental health.

Rolling stock engineer (responsible for the modernisation of tube carriages including cabins)

Health Safety & Environment Advisor. We will contact them to verify that the device can be used within regulations. We have also been advised to contact him to liaise with rail unions (ASLEF and RMT)

Project plan

TFL validation

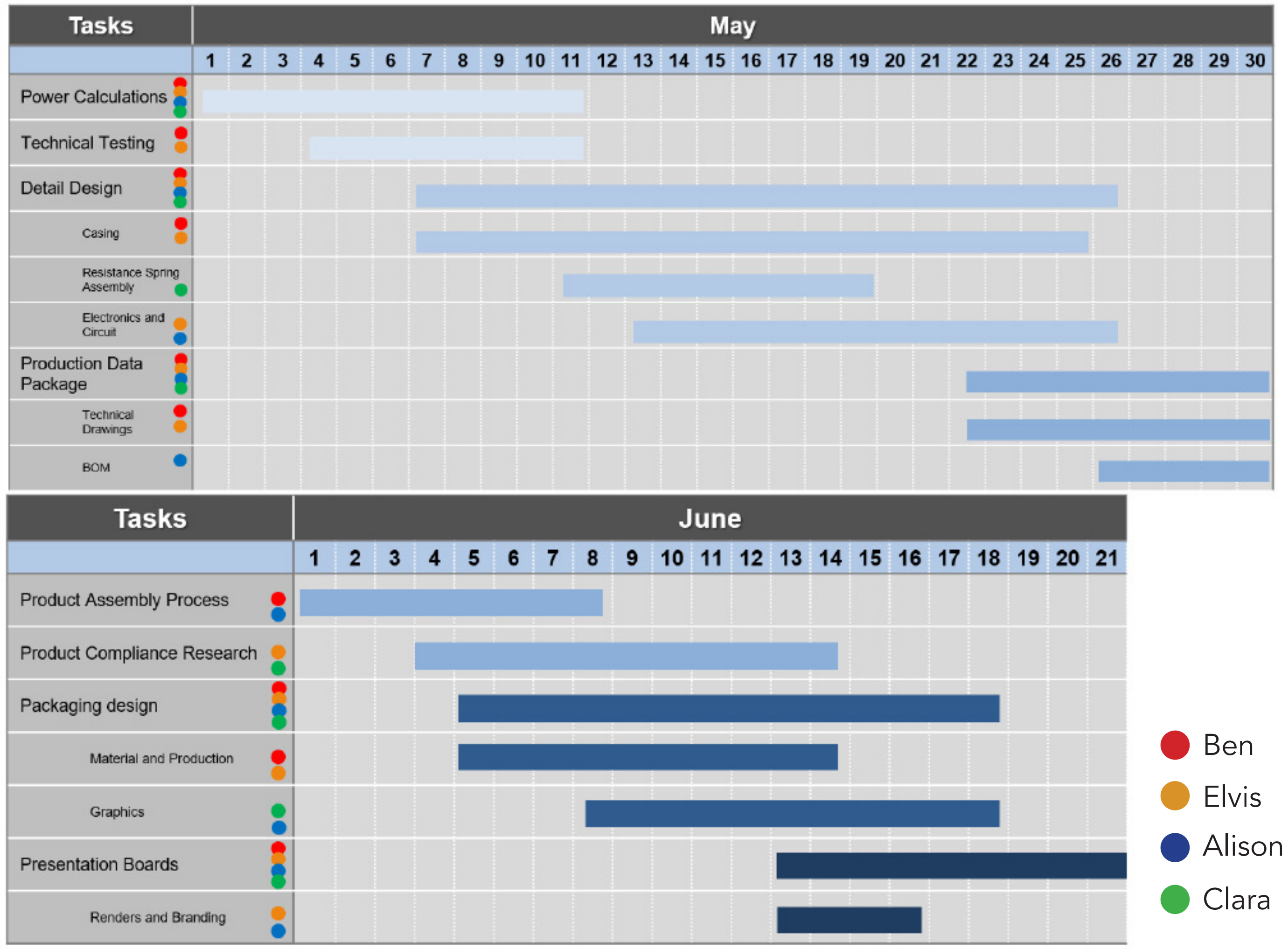
Milestones Updates

Project Milestones: Predicted vs. Actual

A list of all early/late deadlines. Any not included below were achieved in good time.

Action	Time (days)	Predicted Deadline	Actual Deadline	Notes
Technical Testing	8	11 May	14 May	Spent extra time a the start of Phase 3 to refine our concept further before starting testing.
Casing	19	25 May	12 June	Took considerably longer than expected due to failed prints (25hrs +) and tolerance issues.
Mechanism	9	19 May	4 June	Tuning the spring back system was difficult and took 8 iterations due to weakness of spring.
Electronics	14	26 May	7 June	Struggled to reach necessary current output with donor dynamo - soldering not taken into account.
Technical Drawings	9	30 May	17 June	Overran due to late completion of casing - only took 1 day, 9 was overkill.

Action	Time (days)	Predicted Deadline	Actual Deadline	Notes
Assembly Process	8	8 June	16 June	Delayed due to late casing, again 8 days was overkill, only took 1.
Packaging	14	18 June	18 June	Finished on time, but started 8 days late - had to rush this part slightly due to poor planning.
Video	0	N/A	16 June	Not taken into account in Gantt chart, took 2 days to edit and even longer to film.
Branding and Renders	4	16 June	18 June	Rendering overran due to difficulty with Keyshot, had to learn the software very quickly so took longer.
Compliance	11	14 June	11 June	Only took 1 day - overestimated how much work was required, so completed early.



Work Allocation Evaluation

We also assumed a lot when allocating tasks at the end of Phase 2. Below are some notable changes to the planned allocation.

RESISTANCE SPRING ASSEMBLY - originally planned to be Clara, Ben took over this task as the team agreed he had access to a 3D printer and was more confident with CAD.

ELECTRONICS AND CIRCUIT - Elvis could not help with this task as the casing design overrun our timings, therefore Clara took his place with Alison who was leading the task.

PRODUCTION DATA PACKAGE - it was a bad idea to allocate all 4 team members to this. Instead Elvis and Ben completed this task, making it easier to create a BOM alongside completing technical drawings.

PACKAGING DESIGN - It did not make sense to have separate groups for design and graphics as they needed to be made in tandem, therefore Alison and Clara completed this by themselves.