MERICAN
STUDIO

REVENG

Braun MobileShave M-60b

Lara Merican • 02382776 • 2024

Contents

Technical summary

Merican Studio was consulted by Burns Corp to redesign the Braun MobileShave M-60b based on their company values. Burns Corp is a design company which prioritises high quality, ‘excellent’ products while making a killing profit. Alongside Burns Corp’s values, Merican Studio vows to make a positive impact on the environment. This report goes into depth to explain the teardown and product analysis process, which ultimately provided Merican Studio with the understanding to redesign the product.

The Braun MobileShave M-60b was found to have a total embodied energy of 21 MJ and a total CO_2 footprint of 1.11 kg. 89.2% of the embodied energy was due to the materials of the components, with 29% coming from 3 particular components made out of PC+ABS. Merican Studio had the following revisions:

- PC+ABS components were changed to polyvinyl chloride (tpPVC)
  - Total embodied energy was reduced by 2.6MJ
  - Total CO_2 footprint was reduced by 0.17 kg
  - Cost reduced from PC+ABS (2.63 - 3 GBP/kg) to tpPVC (1.32 - 1.44 GBP/kg)
- Shaver blades were subjected to further manufacturing methods to make them sharper
  - Quality of product increased
  - Additional cost and energy needed
- Overmolded rubber grip was added to the shaver casing
  - Quality of product increased
  - Additional cost and energy needed

Overall, the cost to make the product has balanced out to improve the quality of the product, aligning with Burns Corp’s value to make high quality products with a high profit. Additionally, the environmental impact has improved, aligning with Merican Studio’s values.

1 Introduction

Merican Studio is a design consultancy company based in London, United Kingdom which works with various product design companies. This report focuses on a brief provided by Burns Corp who requested a product redesign based on their company values. Burns Corp aims to make products which are 'excellent', industrial and to make a killing profit. Hence, the product should be redesigned to be of high quality and high profit.

This report outlines the product teardown, analysis and redesign of the Braun MobileShave M-60b. Following general research about the product, comparison with similar products and user reviews, Merican Studio performed a product teardown, constructing a bill of materials (BOM) of all the components in the product. These components were then analysed based on their material, manufacturing method and environmental factors such as embodied energy and CO_2 footprint - CES Edupack's Eco Audit tool was used to calculate these. The product was then redesigned to fit client values and improve environmental impact.

2 Background

2.1 General information about Braun MobileShave M-60b

The Braun MobileShave M-60b is a battery powered electric shaver with an oscillating blade designed to trim facial hair with ease. On Argos, the Braun MobileShave M-60b is selling at £20 (1) - the second cheapest electric shaver on the website.

Key features include:

- SmartFoil™ - Protects users by covering blades while cutting hairs grown in varying directions.
- Washability - Product is entirely waterproof hence materials are unaffected by water and should remain to do so.
- Safety lock - A feature noticed by many users which prevents the product from accidentally turning on.
- Twisting cap - Covers the shaver head when not in use.

2.2 Product comparison

Electric shavers on Argos range from £17 to £500 (2), with products coming from 3 main brands - Braun, Philips and Remington.

Figure 1: Cheapest and most expensive products from Braun, Philips and Remington (2)

From observation of Figure 1, the most expensive electric shavers have more shaver heads, an overmolded grip and a digital screen. These features may be kept in consideration, however, as the Braun MobileShave M-60b is one of the cheapest and simplest Braun products, it should remain accessible to people of low income.

2.3 Product reviews

From various reviews on Amazon, users seemed to not be satisfied with the quality of the blades themselves leaving comments such as “all it does is pull the hairs” and “poor shaving performance” (3). This was taken into consideration during the redesign process.

3 Method

3.1 Teardown method

Firstly, the product was taken out of its packaging - a plastic cover and cardboard sheet. It was then tested by turning it on and was found to be working.

The team then began the product teardown process by removing the 2 AA batteries and the shaver brush. We started to disassemble the product from the shaver head, taking apart the blade cover, SmartFoil™ and blades. The bottom part of the product was then disassembled, allowing for the motor to be taken out. All internal parts in the main plastic case were removed by unscrewing screws (using the suitable screwdriver head) and pulling components apart. Up until this point, all of the components were taken out relatively easily.

Due to the manufacturing of the main plastic case which consisted of some overmoulded components, secure snap fits and superglue, the team faced some difficulties with the teardown process at this stage. However, with the use of pliers and chisels, the components of the main plastic case could be forced apart

.

3.2 Weighing mass

Once the product was disassembled into its smallest components possible, each component was weighed and recorded onto CES Edupack's Audit Tool. One issue at this stage was that the weighing scale had a resolution of 1 g and was not able to detect the mass of the smaller components. In this case, we weighed components of the same material together and recorded a combined mass.

3.3 Material identification

Fortunately, the majority of plastic components were labelled with their specified plastic type and thus could be easily recorded. However for those without labels, a flame test was carried out to identify their material. Results were then compared to the "Plastics and Elastomers Identification Chart" as shown in Appendix B.

Most metal components were found to be ferrous with a simple magnet test. From the product descriptions on Amazon (4) and Ebay (5), the shaver blades and SmartFoil™were stated to be stainless steel. Other metal components were estimated or guessed.

4 Product analysis

4.1 Bill of materials

A bill of materials (BOM) was generated with CES Edupack, displaying each component's mass, material, manufacturing method, embodied energy and carbon footprint. The full bill of materials and Eco Audit Report can be found in Appendix C and D alongside a teardown board labelled with part numbers in Appendix A. Table 1 shows a summary of the 10 components with the highest embodied energy and carbon footprint. Note that masses under 1 g / 0.001 kg are estimated due to the resolution of the scale. Additionally, a level of confidence is included in the material and manufacturing method columns with the following notation:

- Verified (V)
- Educated Estimate (E)
- Guess (G)

Table 1: Summarised bill of materials with critical components

Part no.	***Part name***	***Quantity***	***Mass (kg)***	***Material***	***Manufacturing method***	***Embodied Energy (MJ)***	***Carbon footprint (kg)***
20	Motor	1	0.033	Subsystem		**8.20000**	**0.39000**
13	Main casing	1	0.035	PC+ABS (V)	Injection Moulded (V)	**4.08000**	**0.21400**
28	AA Battery	2	0.045	Subsystem		**1.90000**	**0.14000**
12	Twisting cap	1	0.014	PC+ABS (V)	Injection Moulded (V)	**1.66000**	**0.08670**
18a	Motor holder	1	0.007	PC (V)	Injection Moulded (V)	**0.87000**	**0.05070**

3a	Blades holder	1	0.0015	PTFE (V)	Injection Moulded (V)	**0.47300**	**0.02660**
2	Blade cover	1	0.003	PC (V)	Injection Moulded (V)	**0.37600**	**0.02220**
27	Outer battery cover	1	0.003	PC+ABS (V)	Injection Moulded (V)	**0.35900**	**0.01860**
9a	Motor linkage case	1	0.0028	POM (V)	Injection Moulded (V)	**0.28500**	**0.01230**

4.2 Materials used

The teardown process revealed that the product contains 10 polymers (PC, PC-ABS, PC+ABS, PE, PP, PTFE, POM, nylon, polyurethane and silicone elastomer) and 4 metals (low carbon steel, stainless steel, aluminium and nickel-plated steel). The data in the discussion below was taken from CES Edupack unless stated otherwise:

4.2.1 Polymers

PC-ABS and PC+ABS are both blends of polycarbonate (PC) and acrylonitrile butadiene (ABS), hence sharing similar properties. Generally PC/ABS is a favourable material as it is relatively lightweight (6) compared to other materials, making it suitable for a portable electric shaver. It also has high toughness, heat resistance and tensile strength (40 - 51 MPa) hence it cannot be broken easily. However, PC/ABS blends generally tend to be more expensive (2.63 - 3 GBP/kg) than PC or ABS on its own (except for pure PC) (7). Furthermore, the components made from PC+ABS are environmentally unfavourable, contributing to the highest embodied energies (97 - 107 MJ/kg) and carbon footprint (4.63 - 5.11 kg/kg) as shown in Table 1.

While the difference between PC-ABS and PC+ABS is unclear through research, observation shows that PC-ABS components are opaque, while PC+ABS components are translucent. PC is typically transparent (8), while most ABS materials are opaque (9), suggesting that PC-ABS has a higher proportion of ABS while PC+ABS has a higher proportion of PC. The optimum ratio for favourable mechanical properties is a 60:40 PC/ABS ratio (10) hence this ratio was used in the bill of materials for PC+ABS. However, note that this is an educated estimate.

PC can be more costly than other polymers (1.85 - 2.37 GBP/kg). However its properties of being lightweight (1.19 - 1.21 g/cm^3), non-toxic and impact resistant outweigh the cost disadvantage. A Price vs Density Ashby plot can be found in Appendix E.

PTFE is not only the second most expensive polymer (9.16 - 10.3 GBP/kg), but also the most dense (2.14 - 2.20 g/cm^3). However, it is non-toxic, very insoluble and thermally stable with a melting point of 327˚C (11). This material is only used in one component which is connected to the blades, which may be a reason why PTFE was chosen, due to the high kinetic energy of the blades.

Most components in the shaver were made of **POM**. It has high tensile strength (71.5 - 89.6 MPa), impact strength and has good water resistance. It also has a high relative cost (0.976 - 1.13 GBP/kg) compared to other polymers, making it a favourable material for high profit. One of the drawbacks is that its density is high (1.39 - 1.41 g/cm^3) compared to other polymers.

Apart from **polyurethane** and **silicone elastomers**, the rest of the polymers are recyclable.

4.2.2 Metals

Stainless steel is a ferrous alloy of iron with chromium and nickel. Since it has chromium, it can form an oxide layer and be resistant to corrosion. It has high hardness (170 - 438 HV) and a very high tensile strength (515 - 1300 MPa) which is required for a sharp blade. In addition, stainless steel is considered to be hypoallergenic, however some may face irritation based on nickel release rates (12).

Low carbon steel has a low carbon content and hence is ductile - this allows the metal components to bend slightly without fracturing easily under load. It is also very cost-effective (0.524 - 0.552 GBP/kg) and hence a suitable choice for non-critical components.

4.3 Manufacturing methods

Injection moulding was the primary process that formed most of the components, as most components were thermoplastic. Due to its efficiency in high production and low cost per component (13), it is a suitable manufacturing method for Braun's electric shavers. Injection moulding also allows identical products to be made repeatedly which is ideal in this case.

After using bulk deformation processes (e.g. rolling, forging) to form a metal sheet, sheet metal working methods such as **blanking** and **stamping** were used for some metal components. These are educated estimates for the manufacturing of components such as the SmartFoil™and blades. Metal stamping allows for intricate designs to be cut into the sheet metal as shown in Appendix E.

At first, the components in Figure 7 of Appendix E were thought to be small plastic rivets, however after further research, it is more likely that **heat staking** was done - a fastener-free method to join components (14). Heat and pressure are used to melt a plastic component to join it to another surface. This reduces the need for extra fasteners and thus reduces cost as well.

4.4 Embodied energy and CO_2 footprint

Using CES Edupack's Eco Audit tool, the embodied energy and CO_2 footprint of each component's material and manufacturing method were calculated. Embodied energy is the total energy to produce a material or product (15). CO_2 footprint is the "total amount of greenhouse gases generated" by the manufacturing of the product (16).

Table 2: Energy and CO_2 footprint for each phase

Phase	Energy (MJ)	Energy (%)	CO2 footprint (kg)	CO2 footprint (%)
Material	18.7	89.2	0.943	84.9
Manufacture	1.6	7.6	0.12	10.8
Transport	0.618	3.0	0.0445	4.0
Use	0	0.0	0	0.0
Disposal	0.0462	0.2	0.00323	0.3
Total (for first life)	**21**	**100**	**1.11**	**100**
End of life potential	-0.0289		-0.00144	

From Table 2, it is clear that the major contributor to embodied energy and CO_2 footprint is the material phase. It makes up 89.2% of the energy and 84.9% of the CO_2 footprint.

As shown in Table 1, the components that contribute the highest embodied energies are the motor, main casing, batteries and twisting cap. These 4 components add up to 15.84 MJ of embodied energy, which is already 75% of the product's total embodied energy. Hence, it would be best to focus on these components during the redesigning stage (although the motor is not likely to change).

5 Redesign solution

5.1 Understanding client's values

Burns Corp aspires to have products that are 'excellent', industrial and to make a killing profit. Hence, there must be a trade-off between quality and cost. However, it is important to remember that this product is supposed to be the most accessible electric shaver, as it is the cheapest electric shaver Braun has.

5.2 Modification of main casing, twisting cap and outer battery cover

Alongside satisfying the client's criteria, we believe that improving the environmental impact is important. Hence, PC+ABS should be changed to a different material with lower embodied energy and CO_2 footprint. With these in mind, we developed a criteria for the new material:

- Non-toxic & water resistant
- Tensile strength of at least 40 MPa
- Recyclable
- Embodied energy lower than 97 MJ/kg
- CO_2 footprint lower than 4.63 kg/kg
- Cost lower than 2.63 GBP/kg
- Manufacturing method: Injection moulding

By inputting this criteria into CES Edupack Level 2, a CO_2 footprint vs Embodied energy Ashby plot was created as shown in Figure 2.

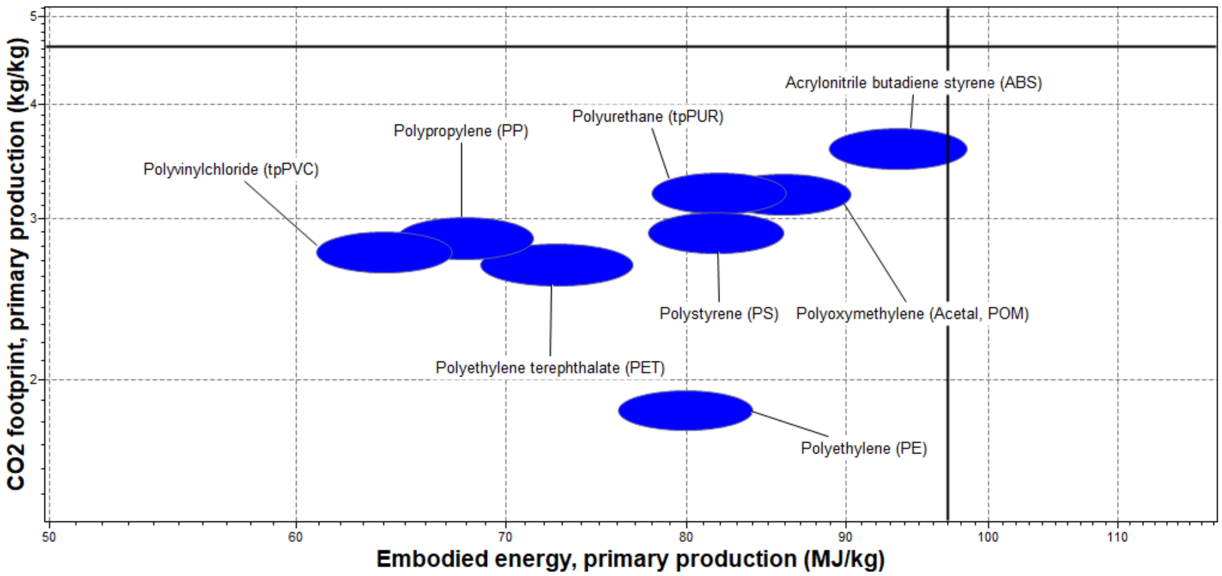


Figure 2: CO_2 footprint vs Embodied energy Ashby plot

Table 3: Properties of best 3 materials from Ashby plot

	Price (GBP/kg)	***Density (kg/m^3)***	***Tensile strength (MPa)***
Polyvinyl Chloride (tpPVC)	1.32 - 1.44	1.29×10^{-3} - 1.46×10^{-3}	38 - 46
Polypropylene (PP)	0.961 - 1.01	895 - 909	26 - 50
Polyethylene terephthalate (PET)	0.541 - 0.954	1.29×10^{-3} - 1.39×10^{-3}	55 - 60

PP was deemed not to be suitable for an electric shaver due to its high density - it would make the shaver heavy and inconvenient to carry.

Although **PET** has the lowest price and highest tensile strength, it does not align with the client's values. PET is generally used for water bottles and can be perceived as a low quality material. As Burns Corp wants 'excellent', industrial products, PET would not be a good fit.

While **tpPVC** has the highest price, it still has a substantially lower price than PC/ABS (2.63 - 3 GBP/kg), has a low density and a similar tensile strength to PC/ABS. It also has the lowest embodied energy (60.9 - 67.2 MJ/kg) and a CO_2 footprint of (2.63 - 2.9 kg/kg). Although tpPVC is not traditionally associated with electric shavers, Merican Studio decided it would be suitable considering the fact that this is the cheapest and most accessible electric shaver in the collection.

Table 4: Changes in embodied energy and carbon footprint with tpPVC

Part no.	*Part name*	*Mass (kg)*	PC+ABS		tpPVC	
			Embodied Energy (MJ)	*Carbon footprint (kg)*	*Embodied Energy (MJ)*	*Carbon footprint (kg)*
13	Main casing	0.035	4.08000	0.21400	2.352	0.1015
12	Twisting cap	0.014	1.66000	0.08670	0.9408	0.0406
27	Outer battery cover	0.003	0.35900	0.01860	0.2016	0.0087
			6.099	**0.3193**	**3.4944**	**0.1508**

5.3 Modification of blades

Manufacturing the blades using blanking may not make the blades sharp enough. This may be a reason why users complain about “poor shaving performance” or that the shaver just “pulls the hairs”. To make an ‘excellent’ and industrial product, the blades should be sufficiently sharp. After the blanking process, perhaps using an angle grinder and sander to manufacture the blades would improve the performance of the shaver (17).

5.4 Further improving quality

As shown in the ‘Background’ section, higher quality electric shavers tend to have an overmolded rubber grip on the main casing. Although this may have a negative environmental impact and higher cost, Burns Corp’s main priority is to have ‘excellent’ products. With the overmolded grip, the product would be more industrial and more people may buy it, leading to more revenue. This may counteract the higher cost and lead to increased profit.

6 Conclusion

Initially, the Braun MobileShave M-60b was found to have a total embodied energy of 21 MJ and a CO_2 footprint of 1.11 kg, with a large proportion of this being contributed by the materials of the product. After a thorough teardown and analysis of the product and its components, Merican Studio found that the 3 components made of PC+ABS had the most negative environmental effect, accounting for 29% of the total embodied energy.

In the redesign stage, Merican Studio concluded that the most suitable material for the main casing was tpPVC - a more environmentally favourable material which reduces the total embodied energy by 2.6 MJ and CO_2 footprint by 0.17 kg. Additionally, tpPVC is a cheaper material (1.32 - 1.44 GBP/kg) compared to PC+ABS (2.63 - 3 GBP/kg), which aligns with Burns Corp’s value of making a killing profit. The further sharpening of blades was implemented in order to increase the quality of the product which was needed to achieve the criteria of the client as well as satisfy users who had bad experiences with the product. Despite increasing cost and embodied energy, the overmolded rubber grip was added to increase product quality as Burns Corp values ‘excellent’ products.

7 Appendices

A Teardown board

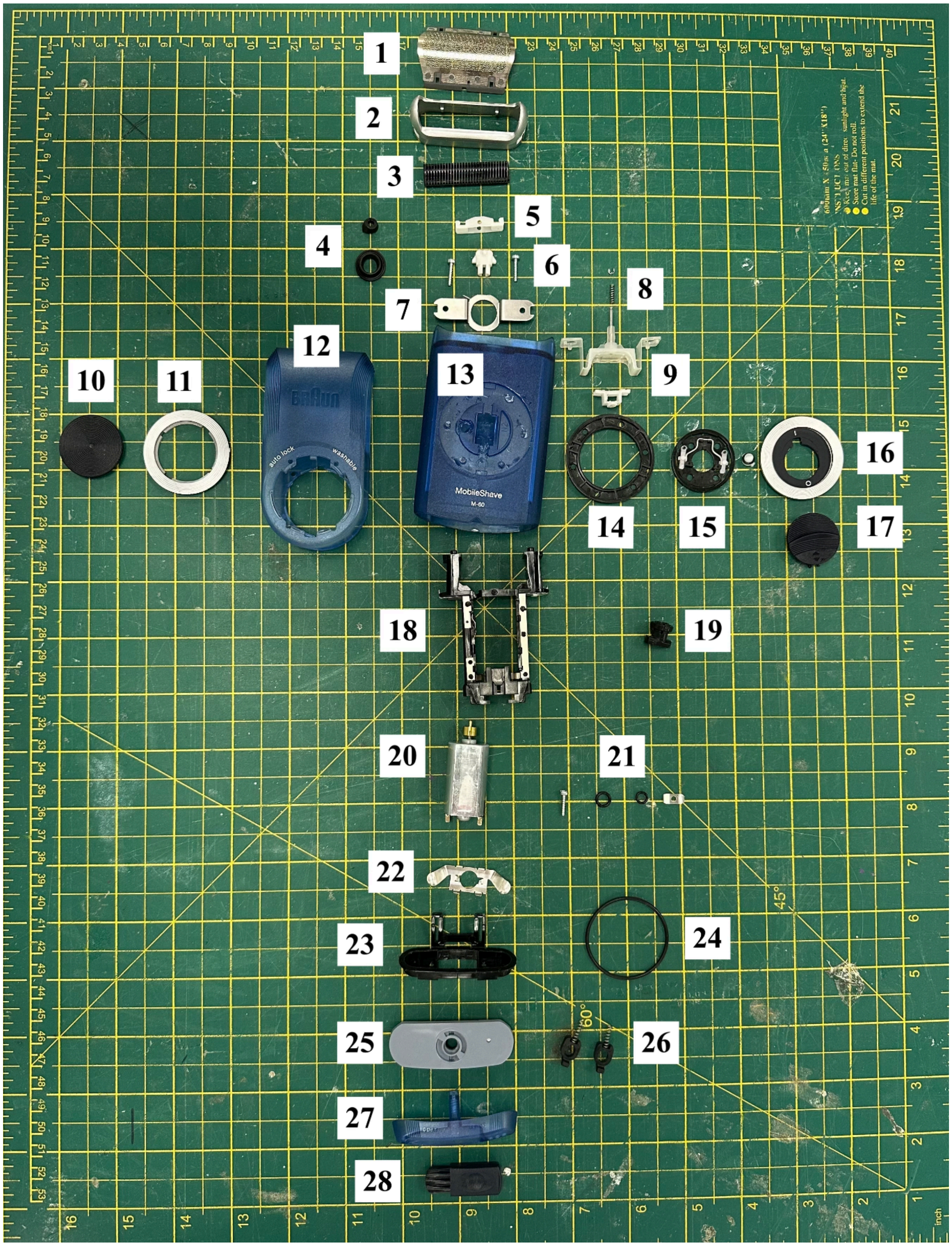


Figure 3: Teardown board of Braun MobileShave M-60b

B Plastics and Elastomers Identification Chart

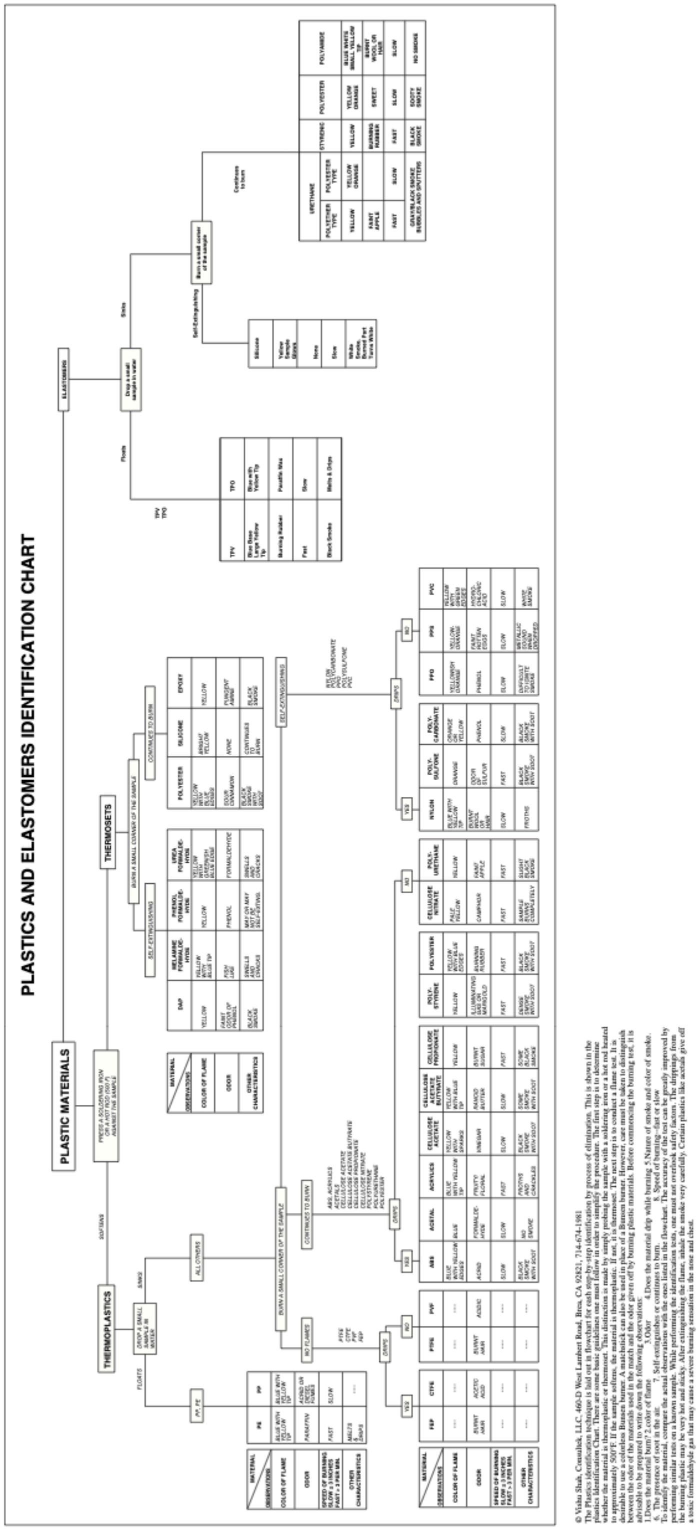


Figure 4: Plastics and Elastomers Identification Chart

C Full bill of materials

Link to full Google Sheet: Bill of materials

Table 5: Full bill of materials

Part no.	***Part name***	***Quantity***	***Mass (kg)***	***Material***	***Manufacturing method***	***Embodied Energy (MJ)***			***Carbon footprint (kg)***		
						Material	***Manufacturing***	***Total***	***Material***	***Manufacturing***	***Total***
1	SmartFoil™	1	0.0002	Stainless steel (V)	Stamping (EE)	0.01500	0.00200	**0.01700**	0.00110	0.00015	**0.00125**
2	Blade cover	1	0.003	PC (V)	Injection Moulded (V)	0.32000	0.05600	**0.37600**	0.01800	0.00420	**0.02220**
3a	Blades	1	0.0005	Stainless steel (V)	Blanking (EE)	0.03600	0.00500	**0.04100**	0.00270	0.00037	**0.00307**
3a	Blades holder	1	0.0015	PTFE (V)	Injection Moulded (V)	0.44000	0.03300	**0.47300**	0.02400	0.00260	**0.02660**
4	O-Ring	2	0.0002	Silicone elastomer (EE)	Injection Moulded (V)	0.12000	0.00296	**0.12296**	0.00132	0.00024	**0.00156**
5	Spacer	1	0.0008	POM (V)	Injection Moulded (V)	0.06900	0.01300	**0.08200**	0.00260	0.00096	**0.00356**
6a	Clip	1	0.0005	POM (V)	Injection Moulded (V)	0.04300	0.00800	**0.05100**	0.00160	0.00060	**0.00220**
6b	Screw	2	0.0002	Low carbon steel (EE)	Forging & Thread rolling (EE)	0.00613	0.00058	**0.00671**	0.00047	0.00004	**0.00051**
7	Metal connector	1	0.003	Low carbon steel (EE)	Punched (EE)	0.00310	0.00029	**0.00339**	0.00023	0.00002	**0.00025**
8	Spring	1	0.0001	Stainless steel (EE)	Wire drawn, coiling (EE)	0.00733	0.00367	**0.01100**	0.00053	0.00027	**0.00081**
9a	Motor linkage case	1	0.0028	POM (V)	Injection Moulded (V)	0.24000	0.04500	**0.28500**	0.00890	0.00340	**0.01230**
9b	Motor linkage pin	1	0.0002	Aluminium (G)	Extruded (EE)	0.03900	0.00300	**0.04200**	0.00260	0.00022	**0.00282**
9c	Spacer	1	0.0005	Nylon (EE)	Injection Moulded (V)	0.07100	0.01100	**0.08200**	0.00350	0.00082	**0.00432**
10	Black circular component (PC)		0.0006	PC (V)		0.00650	0.01100		0.00355	0.00085	
	Black circular component (ABS)		0.0004	ABS (V)		0.03750	0.00850		0.00145	0.00060	

	Black circular component	1	0.001	PC-ABS (V)	Injection Moulded (V)	0.04400	0.01950	**0.06350**	0.00500	0.00145	**0.00645**
11	Silver circular component (PC)		0.0006	PC (V)		0.00650	0.01100		0.00355	0.00085	
	Silver circular component (ABS)		0.0004	ABS (V)		0.03750	0.00850		0.00145	0.00060	
	Silver circular component	1	0.001	PC-ABS (V)	Injection Moulded (V)	0.04400	0.01950	**0.06350**	0.00500	0.00145	**0.00645**
12	Twisting cap(PC)		0.007	PC (V)		0.74000	0.13000		0.04100	0.00970	
	Twisting cap (ABS)		0.007	ABS (V)		0.65000	0.14000		0.02500	0.01100	
	Twisting cap	1	0.014	PC+ABS (V)	Injection Moulded (V)	1.39000	0.27000	**1.66000**	0.06600	0.02070	**0.08670**
13	Main casing (PC)		0.0175	PC (V)		1.80000	0.32000		0.10000	0.02400	
	Main casing (ABS)		0.0175	ABS (V)		1.60000	0.36000		0.06300	0.02700	
	Main casing	1	0.035	PC+ABS (V)	Injection Moulded (V)	3.40000	0.68000	**4.08000**	0.16300	0.05100	**0.21400**
14	Black ring component	1	0.002	POM (V)	Injection Moulded (V)	0.13000	0.02400	**0.15400**	0.00320	0.00180	**0.00500**
15a	Black ring component 2	1	0.001	POM (V)	Injection Moulded (V)	0.13000	0.02400	**0.15400**	0.00320	0.00180	**0.00500**
15b	Wire	1	0.0001	Aluminium (G)	Drawing/extrusion (V)	0.02000	0.00540	**0.02540**	0.00130	0.00041	**0.00171**
16	Switch casing (PC)		0.0012	PC (V)		0.13000	0.02200		0.00710	0.00170	
	Switch casing (ABS)		0.0008	ABS (V)		0.07500	0.01700		0.00290	0.00120	
	Switch casing	1	0.002	PC-ABS (V)	Injection Moulded (V)	0.20500	0.03900	**0.24400**	0.01000	0.00290	**0.01290**
17	Switch	1	0.002	POM (V)	Injection Moulded (V)	0.17000	0.03200	**0.20200**	0.00640	0.00240	**0.00880**
18a	Motor holder	1	0.007	PC (V)	Injection Moulded (V)	0.74000	0.13000	**0.87000**	0.04100	0.00970	**0.05070**

18b	Metal battery contact	2	0.0001	Nickel-plated steel (EE)	Stamping (EE)	0.04600	0.00167	**0.04767**	0.00253	0.00012	**0.00265**
19	Connector	1	0.001	POM (V)	Injection Moulded (V)	0.08600	0.01600	**0.10200**	0.00320	0.00120	**0.00440**
20	Motor	1	0.033	Subsystem		8.20000		**8.20000**	0.39000		**0.39000**
21a	Screw	1	0.0001	Low carbon steel (EE)	Forging & Thread rolling (EE)	0.00307	0.00029	**0.00336**	0.00023	0.00002	**0.00026**
22b	Small O-Ring	2	0.0002	Silicone elastomer (EE)	Injection Moulded (V)	0.02480	0.00296	**0.02776**	0.00132	0.00024	**0.00156**
22	Metal battery contact	1	0.0001	Nickel-plated steel (EE)	Stamping (EE)	0.02300	0.00083	**0.02383**	0.00127	0.00006	**0.00133**
23	Battery holder	1	0.0005	PP (V)	Injection Moulded (V)	0.03400	0.01100	**0.04500**	0.00140	0.00079	**0.00219**
24	Large O-Ring	1	0.0001	Silicone elastomer (EE)	Injection Moulded (V)	0.01240	0.00148	**0.01388**	0.00066	0.00012	**0.00078**
25	Inner battery cover	1	0.001	POM (V)	Injection Moulded (V)	0.08600	0.01600	**0.10200**	0.00320	0.00120	**0.00440**
26a	Spring	2	0.0002	Stainless steel (EE)	Wire drawn, coiling (EE)	0.01467	0.00733	**0.02200**	0.00107	0.00055	**0.00161**
26b	Spring holder	2	0.0008	POM (V)	Injection Moulded (V)	0.06900	0.01300	**0.08200**	0.00260	0.00096	**0.00356**
27	Outer battery cover (PC)		0.0015	PC (V)		0.16000	0.02800		0.00880	0.00210	
	Outer battery cover (ABS)		0.0015	ABS (V)		0.14000	0.03100		0.00540	0.00230	
	Outer battery cover	1	0.003	PC+ABS (V)	Injection Moulded (V)	0.30000	0.05900	**0.35900**	0.01420	0.00440	**0.01860**
28	AA Battery	2	0.045	Subsystem		1.90000		**1.90000**	0.14000		**0.14000**
28a	Brush holder	1	0.002	Polyurethane (V)	Injection Moulded (V)	0.16000	0.03800	**0.19800**	0.00640	0.00280	**0.00920**
28b	Brush bristles	1	0.0001	PE (V)	Extruded (V)	0.00800	0.00062	**0.00862**	0.00019	0.00005	**0.00024**

D Full Eco Audit report

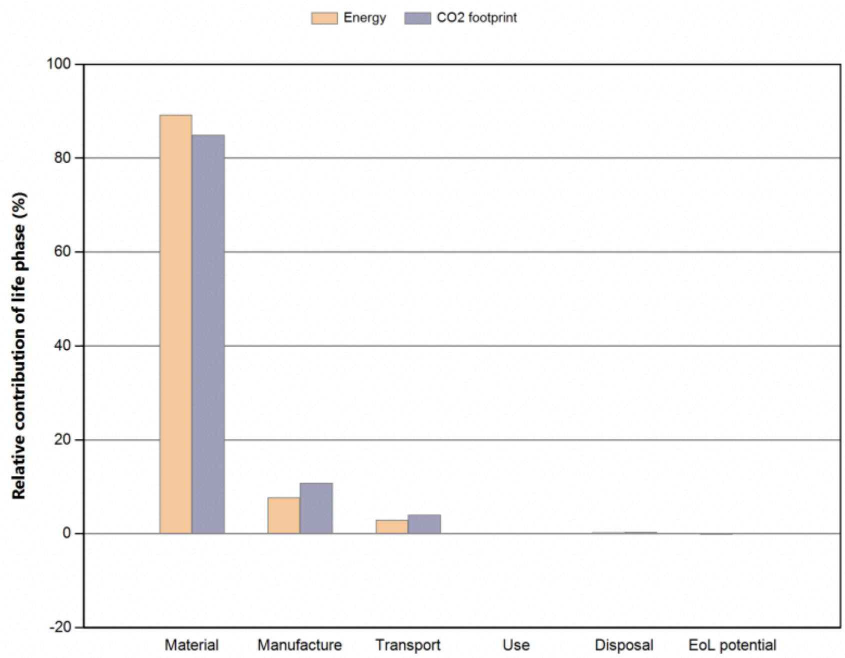
Link to full report: Report.pdf

Ansys
GRANTA EDUPACK

Eco Audit Report

Product name	Braun MobileShave M-60b
Country of use	World
Product life (years)	1

Summary:



Energy details CO2 footprint details

Phase	Energy (MJ)	Energy (%)	CO2 footprint (kg)	CO2 footprint (%)
Material	18.7	89.2	0.943	84.9
Manufacture	1.6	7.6	0.12	10.8
Transport	0.618	3.0	0.0445	4.0
Use	0	0.0	0	0.0
Disposal	0.0462	0.2	0.00323	0.3
Total (for first life)	**21**	**100**	**1.11**	**100**
End of life potential	-0.0289		-0.00144	

Electric shaver.prd NOTE: Differences of less than 20% are not usually significant. See notes on precision and data sources. Page 1 / 15 Wednesday, March 20, 2024

E Other figures

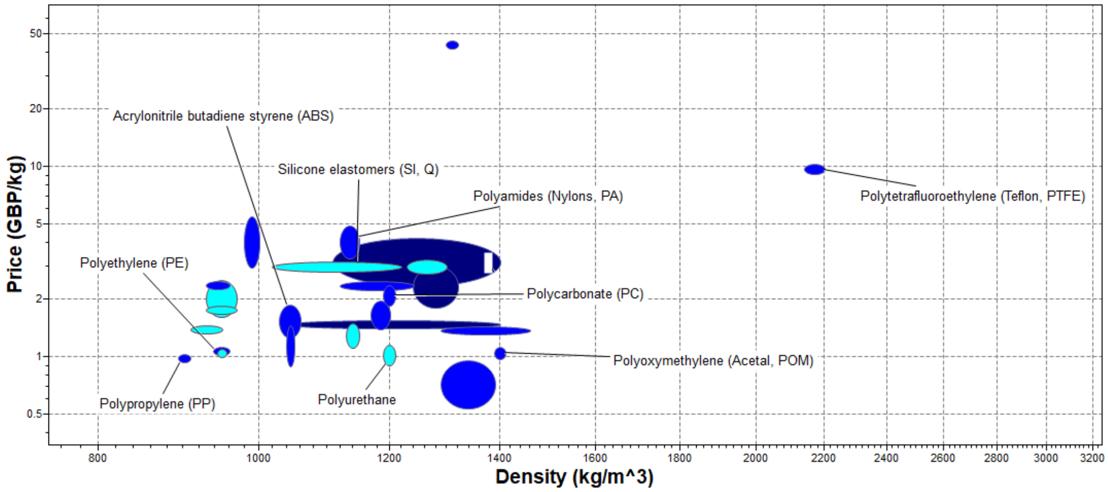


Figure 5: Price vs Density Ashby plot for polymers

Figure 6: SmartFoil™

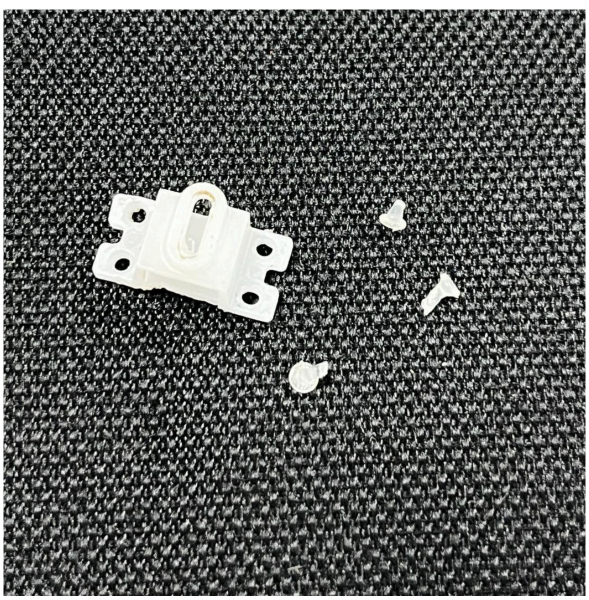


Figure 7: Product of heat staking

8 References

1. *Buy Braun MobileShave Wet and Dry Portable Electric Shaver M-60b | Mens electric shavers*. Argos. https://www.argos.co.uk/product/4434335 [Accessed 19th March 2024].
2. *Mens electric shavers | Argos*. https://www.argos.co.uk/browse/health-and-beauty/mens-shaving-and-grooming/shavers-and-shaving-accessories/mens-electric-shavers/c:29256/opt/sort:price:desc/ [Accessed 19th March 2024].
3. *Amazon.co.uk:Customer reviews: Braun M-60b Men's Trimmer Blue Electric Shaver*. https://www.amazon.co.uk/product-reviews/B002PCPZQA/ref=acr_dp_hist_1?ie=UTF8&filterByStar=one_star&reviewerType=all_reviews#reviews-filter-bar [Accessed 21st March 2024].
4. *Braun PocketGo Mobile Shave Electric Travel Shaver, For On The Go, Fully Washable, Portable Shaver With Travel Lock, M60, Blue : Amazon.co.uk: Health & Personal Care*. https://www.amazon.co.uk/Braun-PocketGo-MobileShave-Portable-Shaver/dp/B002EZZ5NQ?th=1 [Accessed 20th March 2024].
5. *2PCS Shaver Foil for M60 M90 P60 P70 Shaver W9R89038*. eBay. https://www.ebay.co.uk/itm/134894921007 [Accessed 20th March 2024].
6. *PC-ABS: Polycarbonate Material Properties*. https://www.xometry.com/resources/materials/pc-abs/ [Accessed 20th March 2024].
7. *PC-ABS vs ABS:Comparison Of Two Materials*. FOW Mould. 2023. https://www.immould.com/pc-abs-vs-abs/ [Accessed 20th March 2024].
8. *Polycarbonate (PC) - Properties, Uses, & Structure - Guide*. https://omnexus.specialchem.com/selection-guide/polycarbonate-pc-plastic [Accessed 20th March 2024].
9. *ABS Plastic Properties | Advantages Of Acrylonitrile Butadiene Styrene*. https://adrecoplastics.co.uk/abs-plastic-properties/ [Accessed 20th March 2024].
10. Hassan A, Jwu W. MECHANICAL PROPERTIES OF HIGH IMPACT ABS/PC BLENDS - EFFECT OF BLEND RATIO. 2005;
11. *The Properties and Advantages of PTFE*. AFT Fluorotec. https://www.fluorotec.com/news/blog/the-properties-and-advantages-of-polytetrafluoroethylene-ptfe/ [Accessed 20th March 2024].
12. *Metal Allergies*. Serenity Jewellery UK. https://www.serenityjewellery.co.uk/pages/metal-allergies [Accessed 21st March 2024].
13. *Advantages and Disadvantages of Injection Moulding | Protolabs*. https://www.protolabs.com/en-gb/resources/blog/injection-moulding-what-are-the-advantages/ [Accessed 20th March 2024].

14. *Heat Staking | Ferriot, Inc.* Ferriot Inc. https://www.ferriot.com/value-added-services/heat-staking/ [Accessed 20th March 2024].
15. *Embodied energy | YourHome*. https://www.yourhome.gov.au/materials/embodied-energy [Accessed 20th March 2024].
16. *What is your carbon footprint?*. The Nature Conservancy. https://www.nature.org/en-us/get-involved/how-to-help/carbon-footprint-calculator/ [Accessed 20th March 2024].
17. *What is the manufacturing process of a knife?*. https://www.lesartisansducouteau.com/en/page/what-is-the-manufacturing-process-of-a-knife-39 [Accessed 20th March 2024].