IMPERIAL COLLEGE LONDON

DEPARTMENT OF MATERIALS

MATE50003 ENGINEERING PRACTICE

Final Report: SBlender

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Studio G (G16 and 17)

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1 Executive Summary

The blender market's stagnation has opened opportunities for innovative designs. Design Studio G's "SBlender" team focused on simplicity, reliability, and user experience, balancing ethical design, high performance, and cost-effectiveness. Commissioned by a multinational conglomerate, the SBlender aims to rejuvenate the market with a minimalist, sustainable design targeting the low-price luxury segment of £45. Key features include a 1.7 L jug with a handle and spout for easy pouring, baffles to funnel liquids, six angled blades, a quality base casing, and a 400 W DC motor. The blender blade, made from 304 stainless steel, ensures durability, while the cooling blade uses aluminium alloy 6061-T451 for heat dissipation. Key plastics like Polyoxymethylene, Ultra-High Molecular Weight Polyethylene, and flame-retardant Polypropylene meet all specifications. The glass jug is crafted through precision glass blowing, and metal components are fabricated using sheet cutting, cold rolling and bending, ensuring high precision and quality. A detailed financial analysis projects a net negative profit margin in the first month, with breakeven anticipated around month 9. This includes direct costs (materials, capital, manufacturing) and indirect costs (royalties, labour, land, marketing). The SBlender is expected to offer a competitive edge in the high-quality, low-price market segment, with a projected 170% return on investment by the 14th month, selling in increments of 20% of the base 1000 units for the initial month. Sustainability is integral to SBlender's design. A carbon footprint analysis determined 10.89 kg CO_2 equivalent per unit, benchmarked against industry standards. Plans include implementing lifecycle analysis, purchasing carbon credits, and using carbon capture systems to achieve a net-zero carbon footprint, ensuring compliance with environmental standards. Intellectual property considerations were meticulously managed to ensure the SBlender design does not infringe on existing copyrights or patents in the UK, facilitating a smooth market introduction. The SBlender aims to exceed consumer expectations and stand out in the competitive consumer electricals landscape.

2 Introduction

The blender market has seen limited innovation in recent years, revealing potential areas for new designs to rejuvenate consumer interest. Design studio G has been commissioned by a multinational conglomerate to analyse existing competitor's products, and to propose possible improvements. The studio identified 3 main approaches to enhance a blender's design: simplicity, affordability, and longevity. The design proposal meticulously balances ethical design practices, high performance, and cost effectiveness, aiming to exceed consumer expectations and be an excellent stand-out in the competitive landscape of consumer electricals.

The current blender market spans a wide price range, most priced between £20 and £200. The studio aims to target a low-price luxury market, at an approximate price range of £45. High-end blenders, such as the Ninja Blender 2-in-1 (£99) and the Tefal "iMix Tritan" (£170), are priced higher due to features like Auto-IQ technology and touchscreen LED displays[1]. These models were praised for their durability, and high blending efficiency, but are often criticised for their high cost, noisiness, weight and occasional overly complex[2]. On the other hand, budget-friendly models, while more affordable and portable, are prone to poor internal performance, as well as leakages, overheating, insufficient blending power, and safety concerns[3].

Culminating research from different models, namely UTEN's "700 ml 4-in-1 Blender" and Morphy Richards' "Total Glass Control" blenders respectively, permitted the studio to identify potential areas of improvement and propose an improved design. This research allowed the studio to tailor amendments towards the final design proposal of "SBlender", the studio's proposed blender[4,5]. Collectively the research uncovered the following:

- **Jug Design:** Expansion to a 1.7 L jug with handles and baffles along the edges, maintaining a single jug system to achieve the minimalistic and simplistic feel.
- **Stationary Design:** The blender is designed to remain stationary, as portable alternatives were not highlighted as a consumer necessity.
- **Motor Power:** Implementation of a high-powered motor to improve blending capabilities.
- **Component Materials:** Improved design and choice of materials for the jug, blade (cutting and cooling), and coupler, addressing common customer complaints and enhancing overall performance.

The studio's design rationale was informed through a balance between cost, sustainability, and intellectual property considerations. Advanced technologies were selectively used, aligning with market trends that indicate a positive correlation between smarter technologies and product pricing, while also supporting sustainable production.

The report outlines the design proposal, coupled with the materials required and intended manufacturing methods, underpinning the key aspects of our SBlender. The studio restricted themselves on using advanced technologies as current market trends show that there is a positive correlation between smarter technologies and overall price within products - it also aids well in sustainability and production due to manufacturing as previously mentioned[6]. Further, a comprehensive financial analysis was conducted to evaluate the cost associated with all stages of production. Subsequently, a price point was diligently selected by the studio, accounting for the intended market position of the client.

Figure 1: *Jug assembly with lid, jug body, blade and blade holder.*

Throughout the design process, intellectual property considerations were meticulously addressed to ensure compliance with infringement laws. Moreover, sustainability has been a core focus, with a comprehensive carbon footprint analysis being conducted to benchmark the product against industry standards. The studio aims to accurately provide recommendations to the client for improvements moving forward.

SBlender successfully incorporates extensive research and innovative design to present a blender aimed at penetrating the market, through meeting the highest standards of financial and sustainable practices, and intellectual property. The design proposal, including detailed drawings[7], perspectives, and manufacturing methods, positions SBlender as a top contender in the market, offering a user-friendly interface, whilst maintaining a balance between performance, affordability and environmental impact.

3 Design Proposal

The proposed design of SBlender incorporates the design elements and functions, as well as the material selection shown in Table 1. These aspects were imperative towards the studio's aim of ensuring seamless operation through a minimalistic design and user-friendly interface. The blender was split into 2 sections, the jug and base. The former has the blender jug, body, lid, cup and coupler, and the base consists of the body casing, cooling blade, motor and its associated electronics.

Table 1: *Material selection for parts of the blender.*

Part	Material
Top lid	PP (homopolymer, flame-retardant)
Lid seal	PDMS Silicone
Couplers	UHMWPE / POM
Casing	PP (homopolymer, flame-retardant)
Dial	PP (homopolymer, flame-retardant)
Suction cup	PDMS Silicone
Blade Holder	PP (homopolymer, flame-retardant)
Jug	Pyrex (Borosilicate Glass 7740)
Blades	304L stainless steel
Cooling Blade	Aluminium alloy 6061-T451

3.1 Jug components

3.1.1 Lid

The lid plays a crucial role towards enhancing the user experience. The blender lid provides secure attachment to the blender jug using silicone O-ring seals, creating a leak-proof connection, hence, ensuring ingredients are contained during operation. It is made of flame-retardant polypropylene, which is chemical resistant, safe for using of kitchenware as it might be exposed to heat source, resistant to UV light and can be easy manufactured by injection moulding[8].

3.1.2 Blender Jug

The jug has a 1.7 L capacity, capable of housing many ingredients during operation whilst showcasing a heavyweight and high-quality feel, contributing to the luxury and aesthetic design. In addition, the internal aspect of the blender features 4 baffles, positioned equidistant to one another, to generate a turbulent vortex which facilitates the movement of fluids towards the blades, ensuring a homogeneous blend. The jug takes on a hollow cylindrical shape that features markings up to 1.7 L, with additional height to slot the lid securely and prevent spillage from overflow or buoyancy when in operation. To make such markings on the jug, screen printing can be done regardless of the scale of manufacture due to versatility, reproducibility, and low cost. The rounded, slightly offset spout helps users guide where the food contents will be poured out to, with ensured liquid flow and minimal surface tension. Considering anthropometric data relative to hand size, having a 45 mm gap between the jug body and handle allows at least 95% of users to be able to wrap their hand around it for a comfortable grip[9]. The handle part will be slightly heavier and streamlined to compensate compression and grip security when holding.

The jug body is to be made using tempered borosilicate glass (TBS), via blowing, ion exchange and quenching[10]. Its superior thermal shock resistance of 160 – 220 °C and chemical resistance were critical parameters due to the likely exposure to blended hot soups and cold smoothies. While TBS offers greater impact resistance and might be more cost-effective, its high susceptibility to leaching with water and atmospheric humidity lead to subpar corrosion and thermal resistance – but these are insignificant factors that are unlikely to harm the consumer.

3.1.3 Blades

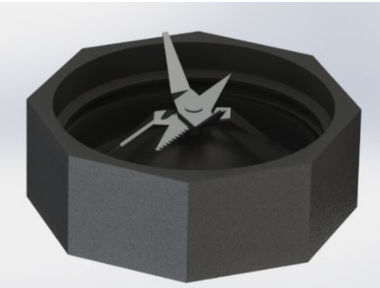


Figure 2: *Close-up of 6-tip, 60º orientated blade configuration incorporated assembled with the blade holder.*

The blender blade plays the crucial role of crushing and grinding solid ingredients. The blade assembly is connected to the motor through a coupler, responsible for transmitting the rotational motion to the blade. Having a 6-tip blade configuration (Figure 2) will increase the frequency and likelihood of successful grinding to ensure ingredients are thoroughly processed, desirable for the consumer. In addition, having one of the blades bent upward provides the ability to cut through buoyant, less dense foods when liquids are present. Furthermore, each tip has been slightly thickened to 2 mm with the middle ones being serrated in addition to their chamfered design, to aid cutting against tougher foods such as ice under high RPM, while preventing the possibility of mechanical failure compared to cheaper models. The component is to be permanently fixed and tightened to the holder for safety; there should be minimal contact towards the user due to its sharp edges.

Taking high level decisions into account, retaining 304L stainless steel was preferrable over its 316L counterpart, due to production costs and sustainability. Although 316L offers better chemical corrosion resistance, 304L stainless steel has sufficient corrosion resistance for the application, with little-to-no negative reviews associating with chemical contamination from existing blenders. Additionally, this steel provides similar mechanical properties (25 kNm kg^{-1} strength, 170 – 210 HV hardness), and less expensive a reduced manufacturing cost, and a lower CO_2 footprint[11]. The 304L steel will be manufactured using bending and sheet cutting methods followed by annealing, as these are inexpensive and suitable for the proposed 2 mm blade thickness. The 304L steel will be manufactured using bending and sheet cutting methods followed by annealing, as these are inexpensive and suitable for the proposed 2 mm blade thickness. The only adjustment in the process is to change the cutting dies to match the teeth shape on the flat blades, which would add little-to-no increase in the overall production cost.

3.1.4 Blade Holder

As seen in Figure 2, the blade holder has 2 primary functions: to connect with the jug body and provide as the base to support the blades during blending. The former involves using threads via twisting to secure the parts together firmly and disallowing any liquids through to the base components. The potential user can also grip around this part well in the need of cleaning the sharp blades – given compressive strength is sufficient to not cause deformation. The inside consists of a hill-shaped base with such geometry to match the angles of the bent blades and reduce the amount of chunky food getting trapped on its edges. On the flip side of the concave shape will contain the coupler (made of UHMWPE, see Table 1), which is responsible for the cutting mechanism of the blades. This is unique against the current blender market, as this component made of 1 material will significantly make a positive impact on sustainability, matching the studios design decisions. Reducing the need for other materials and adhesives such as silicone (O-rings) or epoxy resin (binder), lowers the carbon footprint, especially as disposal. The blade holder is to be made only using PP because it's mechanically strong with an outstanding thermal stability window. Its difficult shape and its ability to homogenize properties across the component makes it suitable for batch scale injection moulding.

3.1.5 Couplers

UHMWPE and POM were selected as materials for the mechanical male and female couplers respectively due to their wear resistance and durability at high temperatures from friction at operation. To aid this, an evenly distributed 6-teeth design was proposed to reduce the amount of force experience per tooth to further lower the rate of degradation. Both being plastics, they can be injection moulded to shape with no further finishes. These materials are expected to endure for at least a year without any replacements, which supports the studio sustainability goals. Two separate polymers were chosen to find a justifiable middle ground between strength and high efficiency across the connection and allowing for a smooth connection regardless of the position of the couplers relative to each other. This is achieved through POM's low coefficient of friction.

3.2 Base components

3.2.1 Base Casing

Figure 3: *Base casing design including the dial's modes.3*

The casings are designed with a cylindrical shape featuring an octagonal base, enhancing both aesthetics and ease of handling. The bottom of the base is fitted with non-slip feet, incorporated to ensure stability during operation, as seen in Figure 3, to streamline the whole blender design. The casing's thickness will be set to 2.5 mm, enough to prevent excess heat transfer to the user from the motor during operation as often complained amongst cheaper competitors. The most suitable material chosen for this part was flame-retardant PP. Generally, its mechanical properties such as toughness and hardness were sufficient over other common polymer alternatives, namely ABS and PVC. However, a few notable differences were identified: ABS is highly flammable, while the other two materials are self-extinguishing, making ABS a less ideal choice due to potential safety hazards in kitchens, where open flames are present. From a cost perspective, all three materials can be injection moulded, resulting in relatively similar processing costs. PVC, despite being the cheapest, exhibits the lowest maximum service temperature of 65°C, which may be reached during operation due to the motor or blended content[12]. Additionally, PP has a lower carbon footprint than ABS. However, the studio proposes to further dip coat this part with a polyurethane layer to provide thermal and acoustic insulation to guarantee the safety of the consumer with a reduced noise output.

3.2.2 User interface (Motor, cooling fan and electronics)

To optimize user experience, a knob can adjust to 3 key modes, Pulse (P), Off (O) and a variable cutting speed mode – see Figure 3. For the latter, the user has more advantage in control of how well their food components can be mixed and preserve the energy used to operate the appliance, given the public in recent times has followed more energy-saving alternatives. Should the motor components begin to overheat, the user is aware of adjusting the knob to preserve the product from breakdown. In addition, it will be made of flame-retardant PP, following the same manufacturing process as its neighbouring casing to fulfil design simplicity.

The choice of the motor unit is left to the discretion of the client or manufacturer, provided it meets the necessary power specifications to ensure optimal functionality. However, the studio suggests a motor unit with a minimum power requirement of 400W, to satisfy a desirable blending performance. The motor itself, cooling blade and couplers must all be connected for the 304L steel blades to spin coherently. The cooling blade has a thin, circular design, with slightly inclined blades to ensure adequate airflow, preventing overheating and potential short circuits. It will be made of an aluminium alloy (6061-T451) through annealing, processed similarly to the blades, and chosen for its excellent thermal stability window up to 150 °C, referenced in appendix 2, thus satisfactory to maintain its function until the products' end of life.

3.2.3 Locking mechanism

The blender jug and base integrate seamlessly with a user-friendly click-based locking mechanism[13]. It operates via insertion of the blender jug onto the base, ensuring the blender coupler aligns diligently with the motor coupler to establish a secure connection with a spring-and-guide cam mechanism. To release the product, simply pressing down on the jug again will reverse the mechanism for the jug to be mobile again. This simple design focuses on working with all kinds of people, including ones with arthritis or weak nervous system. This straightforward locking system ensures the blender operates with minimal effort and maximal results.

3.3 Technical Drawings

See Page 7 onwards.

4 Finance

A comprehensive financial assessment was conducted, considering both the client's investment prospects and market entry costs. The costs have been divided into direct and indirect categories. Direct costs include production expenses per unit, encompassing materials, capital, and manufacturing costs. Indirect costs account for expenses not directly tied to production, such as royalties, labour, land, and marketing.

SBlender's analysis, detailed in Table 2, projects a net negative profit margin for the first month of production. The studio projects to market 1000 units in the initial month, followed by a 20% increment per month. A detailed breakdown of the cost analysis on a monthly production basis is listed in Appendix 3. However, a thorough return on investment (ROI) analysis, presented in Appendix 4, indicates that we will reach the breakeven point around month 9, with a projected 170% return on investment on month 14. Through scalability and economies of scale, the cumulative profit outweighs the fixed costs associated with production. This analysis accounts for the four factors of production: land, labour, capital, and entrepreneurship, ensuring a holistic financial strategy.

Table 2: *Projected expenditure and profit analysis for the first month of production.*

Revenue	**No. of blenders sold**	1000.00
	Price per unit (£)	45.00
	Total revenue (£)	45,000.00
Cost	**No. of blenders made**	1000.00
	Cost per unit (£)	27.54
	Total monthly cost (£)	63,952.57
Profit (£)		-18,952.57

The studio has provided estimates for both up-front costs associated with market entry and per-item costs for a range of sales volumes. All estimates are sourced from auditable references, reproduced in the appendix. The interaction between these estimates, the design rationale, and the target price point has been meticulously discussed, ensuring a clear pathway to profitability, therefore delegation towards further research and development. It is key to note that royalties have not been included as a cost, as it would be discussed further in the intellectual property section, as a function of the net annual profits.

5 Intellectual Property

The SBlender has many novel aspects and is overall an original design not identical to others on the market. However, it bears small but notable similarities to other blenders, and as such, great consideration and care was taken in ensuring the design did not infringe extensively on any existing intellectual property claims. Studio G mainly considered the Patents Act 1977[14] in the United Kingdom and the guidance in the European Patent Office[15] which covers the United Kingdom too.

There were no infringements noted when taking the Patents Act 1977 into account. In regards to the European market, SBlender's blending blades have a minute similarity when comparing it to the Electrolux blender blades[16]; they are winged and angled. However, SBlender's blades, as seen in Figure 2, adopt a serrated tip configuration at different angles to the configuration of the Electrolux's blade where the tips are not serrated, making the two components contrasting. The Electrolux blender is patented in the US, the European Union, and South Korea, meaning these minor infringements are applicable in the United Kingdom[17]. The slim possibility of infringing Electrolux's patent would cause Studio G to pay no more than 5% of the gross profit which could be negotiated down to a further 2-3% as stated in the European Patent Office. Aside from the blades, the SBlender's polygonal base resembles to Seol Yong Sok's design[18]. However, this patent was not renewed beyond 2019, and thus the manufacturer is free to employ this design without legal or financial consequence. The SBlender also bears similarities to competitor designs, e.g., the KitchenAid K400 blender, which also sports baffles in the blender jug and a polygonal base[19]. However, this design (and other similar competitor designs) is unpatented, alluding to the Electrolux patent not being very strict, and/or very marginal royalties requested by Electrolux for infringement upon aspects of their design that tend to be found in most blenders on the consumer market (e.g., winged/angled blades). In this event, Studio G predicts to pay royalties amounting to 2.5% of the gross profit. Thus, for the first year, 2.5% of £275,825 would amount to £6,895.

***Figure 4:** The SBlender logo.*

Studio G encourages the manufacturer to seek intellectual property rights for the SBlender logo, which features artwork, in black, of a (Latin alphabet) capital S superimposed on a capital B, against a plain white background. The logo will help build user familiarity with the product and establish an identity that will make it noteworthy as it emerges onto the market.

6 Sustainability

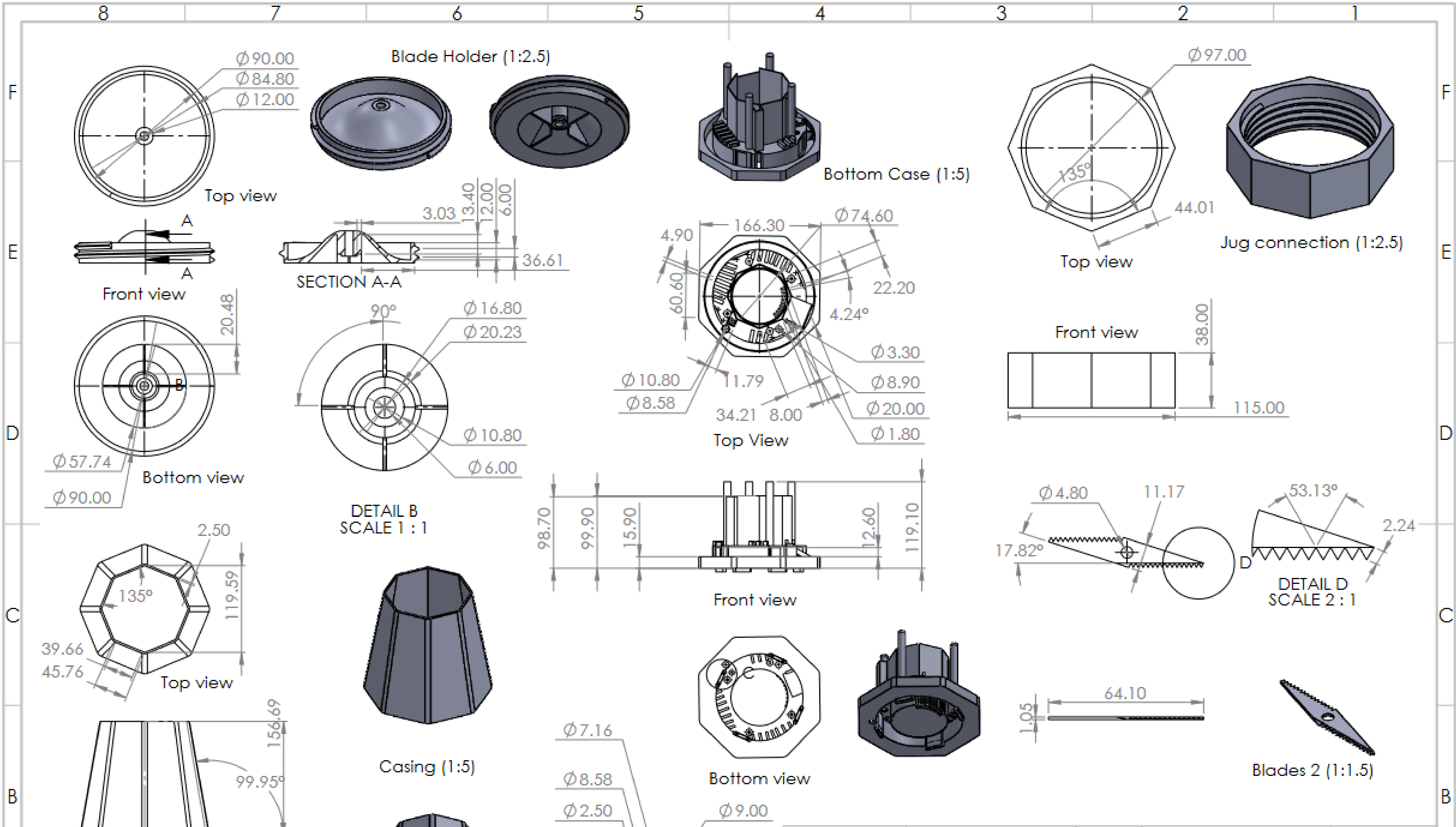
The studio's commitment to sustainability is a core principle guiding the development and production of SBlender. A preliminary assessment has been conducted to quantify the carbon footprint, thereafter, benchmarking it against the industry average. Initial findings indicate the studio's production process resulting in 10.89 kg CO_2 equivalent per unit, calculations shown in Appendix 5.

Moving forward, the studio aims to implement a comprehensive lifecycle analysis to derive a detailed understanding of the environmental impacts at each stage of production, from raw material procurement to end-of-life disposal. This permits identification of critical areas for improvement and develop strategies for further reduction of carbon footprint.

The extraction of raw materials and manufacturing processes account for over 80% of environmental pollutants generated in the life cycle[20]. Plastics pose the biggest issue, where only 9% of the 460 million metric tons produced annually are recycled globally[21]. Although metals and glass are abundantly recycled due to existing schemes, the recycling of certain plastics is not mainstream. Nonetheless, sourcing the materials as alternatives to landfill waste not only reduces environmental impact, but cuts production costs and promotes a circular economy while retaining intrinsic properties.

In alignment with the global sustainability agenda of net zero carbon emissions, several strategies can be employed, such as purchasing carbon credits to offset production emissions and investing in carbon capture and utilisation systems. Implementing these approaches allows the studio to mitigate the environmental impact significantly.

The sustainability efforts extend beyond mere compliance; they represent the studio's commitment to responsible production and continuous improvement. The aim is to not only comply with industry standards but to surpass them to achieve net zero carbon emissions and foster a more sustainable future.



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	NAME	SIGNATURE	DATE
DRAWN	Isabella Wu		
CHK'D	Charles Li		
APPV'D	Tianrui Zhang		
MFG			
Q.A			

MATERIAL:

WEIGHT:

TITLE: Casing (bottom+side), Blade holder, Blades 2, Jug connection part

DWG NO. **Drawing Part 1**

A3

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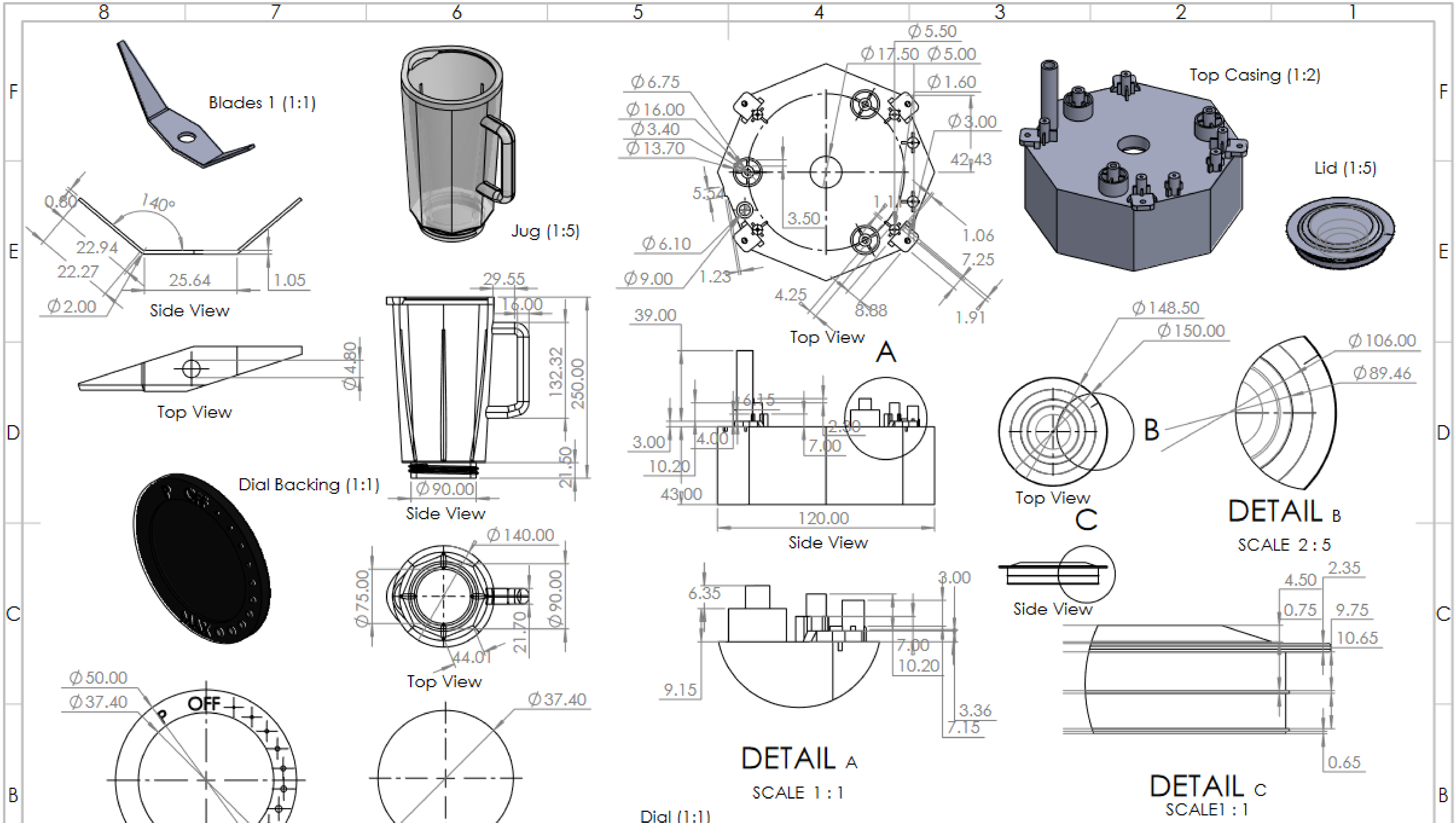
SHEET 1 OF 1



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	NAME	SIGNATURE	DATE
DRAWN	Charles Li		
CHK'D	Isabella Wu		
APPV'D	Tianrui Zhang		
MFG			
Q.A			

TITLE: Blade, Dial backing, Dial, Jug, Top casing

MATERIAL:

WEIGHT:

DWG NO. Drawing Part 2

A3

SCALE:2:1

SHEET 1 OF 1

7 References

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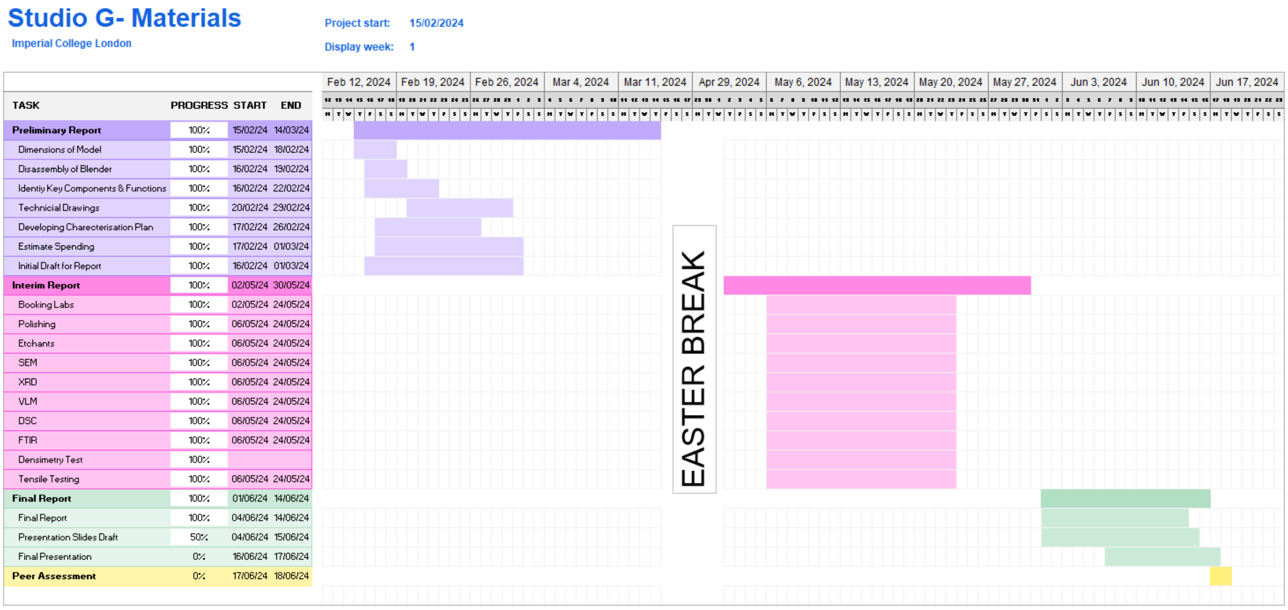
8 Appendices

Appendix 1: *Gantt Chart of Case Study Blender Progress, including final design stage.*



Appendix 2: *Material selection research with respect to the candidate materials of each component.*

Material	**Component**	**Material**	**Manufacturing Method**	**Specific Strength (kN m kg^{-1})**	**Hardness (HV)**
Polymers	**Top lid**	PP	Injection moulded	21.9 – 30.7	8
	Lid seal	PDMS	Injection moulded		3 – 4
	Male Gear	UHMWPE	Injection moulded	22.8 – 29.4	6 – 8
	Female Gear	POM	Injection moulded	40.9 – 51.2	17 – 22
	Casing	ABS	Injection moulded	28.2 – 48.1	9 – 13
		PP	Injection moulded	21.9 – 30.7	8
		PVC	Injection moulded	29.3 – 38.5	12– 16
	Knob	PP	Injection moulded	21.9 – 30.7	8
	Suction cup	PDMS	Injection moulded		
Glass	**Jug**	Tempered	ion exchange + quenching	26	500 – 650
		Borosilicate Glass 7740	blowing	11.3 – 12.5	402 – 443
Metals	**Blades**	316L	solution annealed	21.3 – 38.9	170 – 220
		304L	solution annealed	21.5 – 30.4	170 – 210
	Cooling Blade	Aluminium alloy 6061-T451	Annealing	40.5 – 47.2	70 – 76
	Part	**Material**	**Thermal Stability (°C)**	**Thermal Shock Resistance (°C)**	**Flammability**
Polymers	**Top lid**	PP	-17 – 103		Self-extinguishing
	Lid seal	PDMS			

	Male Gear	UHMWPE	-89 – 110		
	Female Gear	POM	-50 – 97		
	Casing	ABS	-45 – 77		Highly flammable Self-extinguishing Self-extinguishing
		PP	-17 – 103		
		PVC	-10 – 65		
	Knob	PP	-17 – 103		
	Suction cup	PDMS			
Glass	**Jug**	tempered glass	Up to 200	150 – 200	
		Borosilicate Glass 7740	-273 – 490	160 – 220	
Metals	**Blades**	316L	-200 – 925	51.9 – 96.6	
		304L	-200 – 925	50.1 – 72.2	
	Cooling Blade	Aluminium alloy 6061-T451	-273 – 150C	66.7 – 78.7	

	Part	Material	Corrosion Resistivity	Water Resistivity
Polymers	**Top lid**	PP	excellent	Excellent (<0.01%)
	Lid seal	PDMS	good UV light resistance	
	Male Gear	UHMWPE		Excellent (0.005 - 0.01%)
	Female Gear	POM		Excellent water durability (0.2 – 0.22%)
	Casing	ABS	excellent	Excellent (0.2 – 0.45%)
		PP	excellent	Excellent
		PVC	excellent	Excellent
	Knob	PP	excellent	Excellent (<0.01%)
	Suction cup	PDMS		
Glass	**Jug**	tempered glass	excellent	Good but weaker than Pyrex
		Borosilicate Glass 7740	excellent	Great
Metals	**Blades**	316L	Excellent with every reactant	Excellent
		304L	Excellent but lower than 316L	Excellent
	Cooling Blade	Aluminium alloy 6061-T451	/	

	Part	Material	Density (g cm^{-3})	Recyclability	CO_2 Footprint (kg kg^{-1} of material)
Polymers	**Top lid**	PP	0.982-1.16	Yes	2.37 – 2.62
	Lid seal	PDMS	0.87 - 0.98	Downcycle	1.29 – 1.71
	Male Gear	UHMWPE	0.931 - 0.949	Yes	4.07 – 4.51
	Female Gear	POM	1.39 - 1.41	Yes	1 – 1.14
	Casing	ABS	1.02-1.08	Yes	3.41 – 3.77
		PP	0.982-1.16	Yes	2.37 – 2.62
		PVC	1.3-1.49	Yes	2.19 – 2.42
	Knob	PP	0.982-1.16	Yes	2.37 – 2.62

	Suction cup	PDMS	0.87 - 0.98		
Glass	**Jug**	Tempered glass	2.5	Yes	1.125
		Borosilicate Glass 7740	2.2 - 2.25	Yes	1.23 – 1.37
Metals	**Blades**	316L	7.87 - 8.07	Yes	3.74 – 4.45 / 1.29 – 1.42 when recycling
		304L	7.8 - 8.01	Yes	2.5 – 2.94 / 1 – 1.16 when recycling
	Cooling Blade	Aluminium alloy 6061-T451	2.69-2.73	Yes	8.16 – 9.53

Appendix 3: *Initial month cost breakdown for manufacturing 1000 units.*

Cost type	Description	Component	Cost per unit (£)	Amount	Monthly cost (£)
		Direct Costs			
Materials	Borosilicate Glass	Blender jug	7.11	1000	7106.49
	Flame-retardant PP	Casings	0.15		154.00
	Silicon	O-ring seals / Non-slip feet	0.25		249.48
	Aluminium alloy 6061-T451	Cooling blade	0.01		10.35
	POM	Blender coupler	0.01		7.19
	UHMWPE	Motor coupler	0.01		9.16
	304 Stainless Steel	Blender blade	0.02		23.91
Manufacturing	Glass Blowing	Glass jug	1.89		1888.75
	Injection moulding	Plastics	6.87		6869.41
	Cold rolling	Metals	0.05		53.68
	Sheet cutting		0.01		12.85
	Bending		10.18		10180.00
Capital	Glass Blowing	Glass jug	2506.88	3	7520.64
	Injection moulding	Plastics	2000.00		6000.00
	Cold rolling	Metals	650.00		1950.00
	Sheet cutting		1566.36		4699.08
	Bending		154.00		462.00
		Total			*47196.96*
		Indirect Costs			
Land	Warehouse	*NIL*	4030.88	1	4030.88
Labour	Logistics	*NIL*	3329.92	3	9989.75
	Production Engineers	*NIL*	3094.08	4	12376.33
	Design Engineers	*NIL*	2984.33	3	8953.00
Marketing	Google Advertisements	*NIL*	750.00	1	750.00
		Total			*32069.08*
		Grand Total			*79266.04*

Appendix 4: *Return on investment analysis, showcasing a breakeven point of month 9.*

	Sales Throughput / Breakeven Analysis													
	Month													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Sold	1000	1200	1440	1728	2073.6	2488.32	2985.984	3583.181	4299.817	5159.78	6191.736	7430.084	8916.1	10699.32
Cumulative	1000	2200	3640	5368	7441.6	9929.92	12915.9	16499.08	20798.9	25958.68	32150.42	39580.5	48496.6	59195.92
Revenue	45000	54000	64800	77760	93312	111974.4	134369.3	161243.1	193491.8	232190.1	278628.1	334353.8	401224.5	481469.4
Costs	83296.92	67978.25	74353.91	82004.7	91185.65	102202.8	115423.3	131288	150325.6	173170.8	200584.9	233481.9	272958.3	320330
Profit	-38296.9	-13978.3	-9553.91	-4244.7	2126.354	9771.617	18945.93	29955.11	43166.13	59019.35	78043.21	100871.8	128266.2	161139.4
Cumulative Profit	-38296.9	-52275.2	-61829.1	-66073.8	-63947.4	-54175.8	-35229.9	-5274.77	37891.36	96910.71	174953.9	275825.8	404092	565231.4
Return on investment	-46%	-77%	-83%	-81%	-70%	-53%	-31%	-4%	25%	56%	87%	118%	148%	176%

Appendix 5: *Carbon footprint analysis per unit of production of the blender.*

S/N	**Material**	**Mass of material (kg)**	**Carbon footprint (kg CO_2 eq.)**	**Total Carbon Footprint per unit (kg CO_2 eq.)**
1	Borosilicate Glass	1.82	1.13	2.06
2	Flame retardant PP	0.08	2.37	0.18
3	Silicon	0.08	1.46	0.12
4	Aluminium alloy 6061-T451	0.01	8.16	0.05
5	POM	0.01	1.14	0.01
6	UHMWPE	0.01	4.07	0.04
7	304 Stainless Steel	0.02	1.12	0.01
	Machinery	**Mass of material per unit (kg)**	**CO_2 emission per mass (kg CO_2 eq.)**	**Total Carbon Footprint per unit (kg CO_2 eq.)**
1	Glass Blowing	1.82	3.00	5.47
2	Injection Moulding	0.17	1.50	0.26
3	Cold Rolling	4.195	0.10	0.42
4	Sheet Cutting	4.195	0.25	1.05
5	Bending	4.195	0.05	0.21
	Motor Components	**CO_2 emission per unit (kg CO_2 eq.)**	**Number of units**	**Total Carbon Footprint per unit (kg CO_2 eq.)**
1	Standard Motor Component	1	1	1.00
Total Carbon Footprint per unit (kg)				10.89

Appendix 6: *Individual member contributions in writing the final report for SBlender.*

Name	Contribution
Saiful Islam	Finance, Research, Appendix
Francesca Manyonyi	Intellectual property, Executive Summary
Nick Martin	CAD model of new blender, Design Proposal Writing, Renders, Editing/Proofreading
Mervyn Ochoa-Dugoy	SBlender Report Presentation, Introduction, Design Proposal Writing, Materials selection editing, Appendix
Charles Li	Material selection writing, Research, Appendix, Writing/Editing, Technical drawing
Tianrui Zheng	Material selection writing, Research, Appendix, Writing/Editing, Technical drawing, Referencing
Isabella Wu	Material selection writing, Research, Appendix, Writing/Editing, Technical drawing
Afsana Islam	Sustainability research and writing
Aryan Bansal	Finance, Sustainability, Intellectual Property, Research, Writing/Editing, Formatting, Appendix
Yifan Zhou	Sustainability research and writing
Rayla Esquivel	Minor CAD work (Material Volume Calculations), Editing, Formatting
Quinn Han Wong	Executive Summary, Introduction, Design Proposal, Finance, Sustainability, Formatting, Appendix, Writing / Editing

__Appendix 7__ Further renders of proposed blender model