GROUP 72

POSTER 4 – MATERIALS AND MANUFACTURING

The product is designed for outdoor use and portability meaning it will be exposed to natural weather conditions and must be corrosion resistant with an operating temperature between -5° and 30°. [1] The main component must be a material with high yield strength to support a load and be relatively lightweight for portability. The material used for the handles should be comfortable to hold for extended periods of time. In addition, the recyclability and reusability of the materials must be considered, and their overall environmental impact is calculated using an eco-audit. The final consideration is the overall cost of the raw materials and manufacturing method as the product must be affordable.

Component 1: Main shaft**,** telescopic tube
Material: Aluminium Alloy
Manufacturing Method: Sand Casting, Sand Blasting, Machining

The main shaft will have **load from the handle** and will therefore need to be **tough and durable**. For the product to be **easy to use** for people with muscle pain it must **be lightweight** needing the material to have an **excellent strength-to-weight ratio** with aluminium having a **low density** for a metal. The aim of the product is to encourage more **freedom** for people with joint pain and muscle weakness and therefore **outdoor use** will require the material to be **corrosion resistant** such as aluminium. Aluminium ore is abundant however resources are finite, and it takes a **lot of energy to extract** aluminium with its energy content over **300MJ/kg** and a carbon footprint of **13kg/kg** meaning that a portion could be using **recycled aluminium** due to its **high recyclability**. Sand casting has an economic batch size of **1-100K** making it suitable for our product along with being able to produce **complex shapes.** Sand blasting was used to improve the surface finish to make the product **more comfortable** to touch and **aesthetically pleasing.** (2)

Component 1

Component 2: Grips
Material: Rubber
Manufacturing Method: Polymer Moulding

Rubber was chosen due to its **conformability** providing it **high friction** on rough surfaces providing **stability and security** for users. Rubber has **low hysteresis** making it bouncy and allowing for energy restoration **reducing the stress on joints** and making it **comfortable to grip**. Injection moulding was chosen due to its ability to produce shapes with a range of complexity with an economic bath size of **10-1000K** along with a **good surface finish** allowing the user to easily grip. Rubbers are **thermosets** making them **durable** allowing for a long period of use however provides problems when disposed as they **cannot be remoulded, reshaped and recycled**. (2)

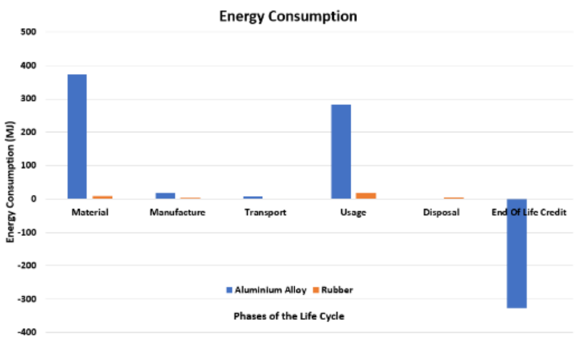
Component 2

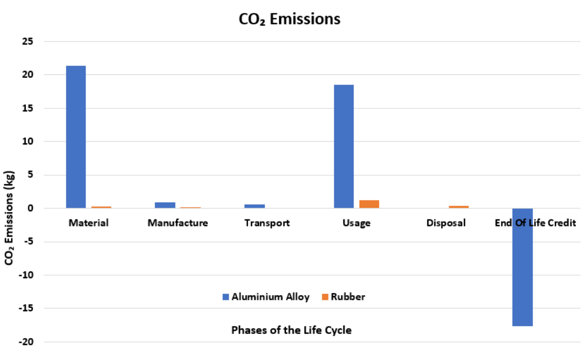
Table 1 Shows the total volume, mass and cost of each material in the product. It is designed to be very light and have minimal volume, whilst keeping the cost low. (2)

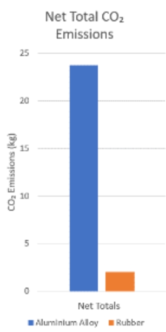
Table 1

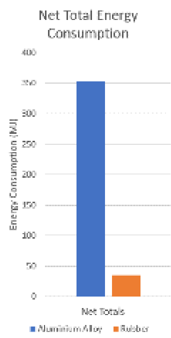
Component	Material	Volume (cm³)	Mass (kg)	Cost (£)
Main Shaft	Aluminium Alloy	660	1.78	3.50
Handle	Rubber	130	0.12	0.40
Total	-	790	1.90	3.90

Eco-Audit: The Eco-Audit is a method used to quickly compare the environmental impacts of different phases in the life cycle for individual materials in the product. This includes the energy consumption and CO_2 emissions, and the goal is to minimise the net total in both those categories.









Assumptions

Materials: Materials for the product used are 100% virgin materials. Mechanical fasteners were not considered. (2)
Manufacture: Only the primary processes have been considered
Transport: Product will travel 21,500 km on a diesel-powered ship from Lanzhou China to the UK. (2)
Use: The difference in CO2 and energy emissions from the addition of 1 product to gasoline family car. The driver was assumed to drive 12,200 km annually from the average distance driven for people aged 65 and over. The product was assumed to have been used for 5 years giving a total distance of 61,200 km. (2)
Disposal: 100% of the aluminium used was recycled. Rubber was assumed to not be recycled. (2)

Conclusions

The graphs created from the eco audit show that in the phase of the products life that has the **largest environmental impact was the material phase.** The **production of the materials** required is very **energy intensive** with high embodied energies and carbon footprints. This was much larger than the energy used in primary processing. Another **significant portion** of the energy use was the **use phase**. This is because over 5 years, the gasoline powered family car will **produce significant emissions**. A way to reduce the environmental impact of this could be reduced **using electric vehicles** which operate on **renewable energy sources**. The graph also shows that **heavier components** have **a larger environmental impact** during the use phase.

To reduce the environmental impact**, recycled aluminium** could be used **reducing the carbon emissions** in the manufacturing process. The product could be redesigned by making some parts hollow **reducing the volume** of the product or using a material with a **lower density**. In the process of redesigning, the effect on the strength of the product must be considered as it **must be suitable for users up to 100kg** according to the requirements list. Another impact could be **durability**, a reduction in the strength of the product may **shorten its lifetime** and may need to be repurchased leading to **increased wastage**.

1) Met Office. (n.d.). Bath (Bath and North East Somerset) UK climate averages. [online] Available at: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate averages/gcnk62de

2) Ashby, M. F. Materials and the Environment : Eco-informed Material Choice. 2nd ed. Waltham, MA: Butterworth-Heinemann, 2012. Web.