CAL STATE EAST BAY

ENGR 660 Project Report

Electric Mop for Car Drying

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Contents

1 Introduction

This project aims to develop an innovative product which will help to ease day-to-day tasks and be convenient for users at lower cost and optimum design. At the same time from manufacturing point of view the raw materials procurement be easily available and sustainable.

2 Product Selection and Reason

The idea selection started with brainstorming and understanding what problems people can come across in daily tasks. The results of brainstorming helped to get down to a few ideas. After approval from project guide, the selected product ideas were rated for the final project and the innovative product ‘Electric Mop for Car Drying’ was selected to work on.

3 Product Idea

Cleaning the car at home is a big task. Many gadgets are available for car wash. But when it comes to drying with clean and dry cloth, there are less options available. Also, manual car dying is time consuming and tiresome job.

Figure 1: Current Product in use

Introducing an innovative and new product, electric mop for car drying with attached microfiber cloth to a long stick to help car owners with quick clean drying experience of the car.

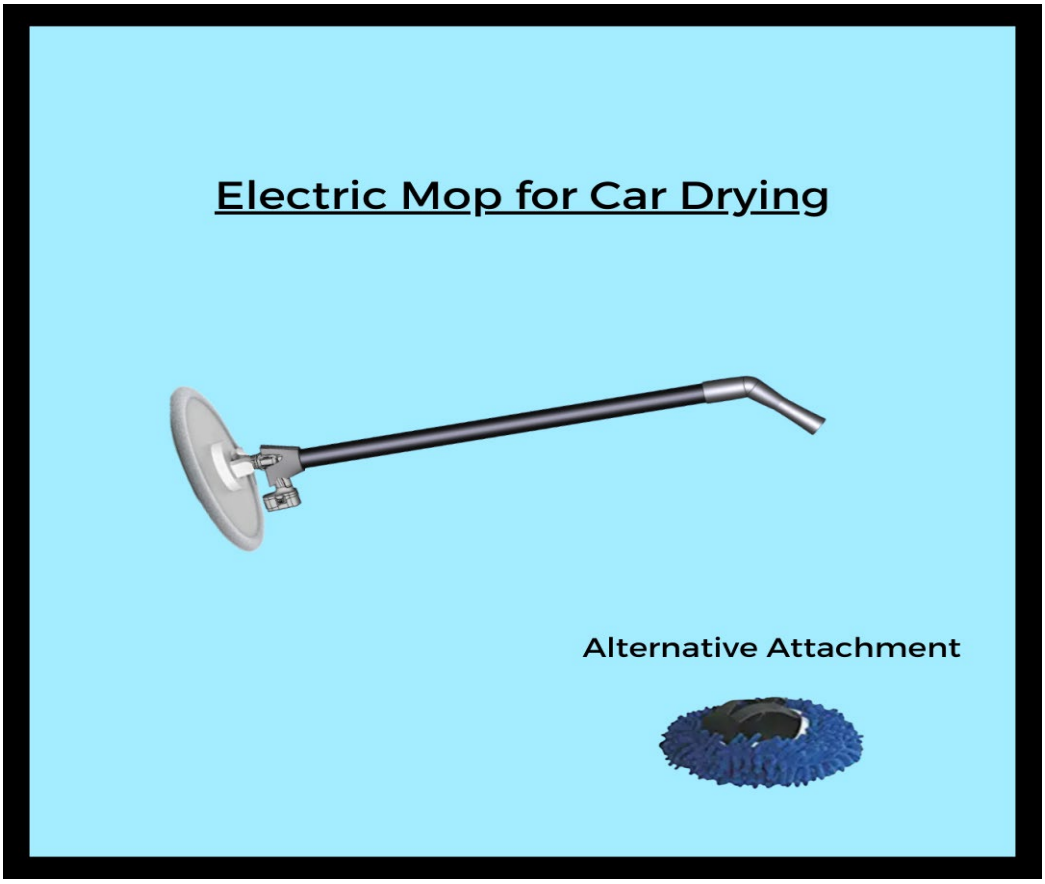

Figure 2: Our Solution Product

3.1 Objective tree

Objectives are features or behaviors that the design should exhibit. There are numerous features this product will have. Objective tree is a way to represent the information that is contained in the features list. Following is the objective tree for Electric mop for Car drying.

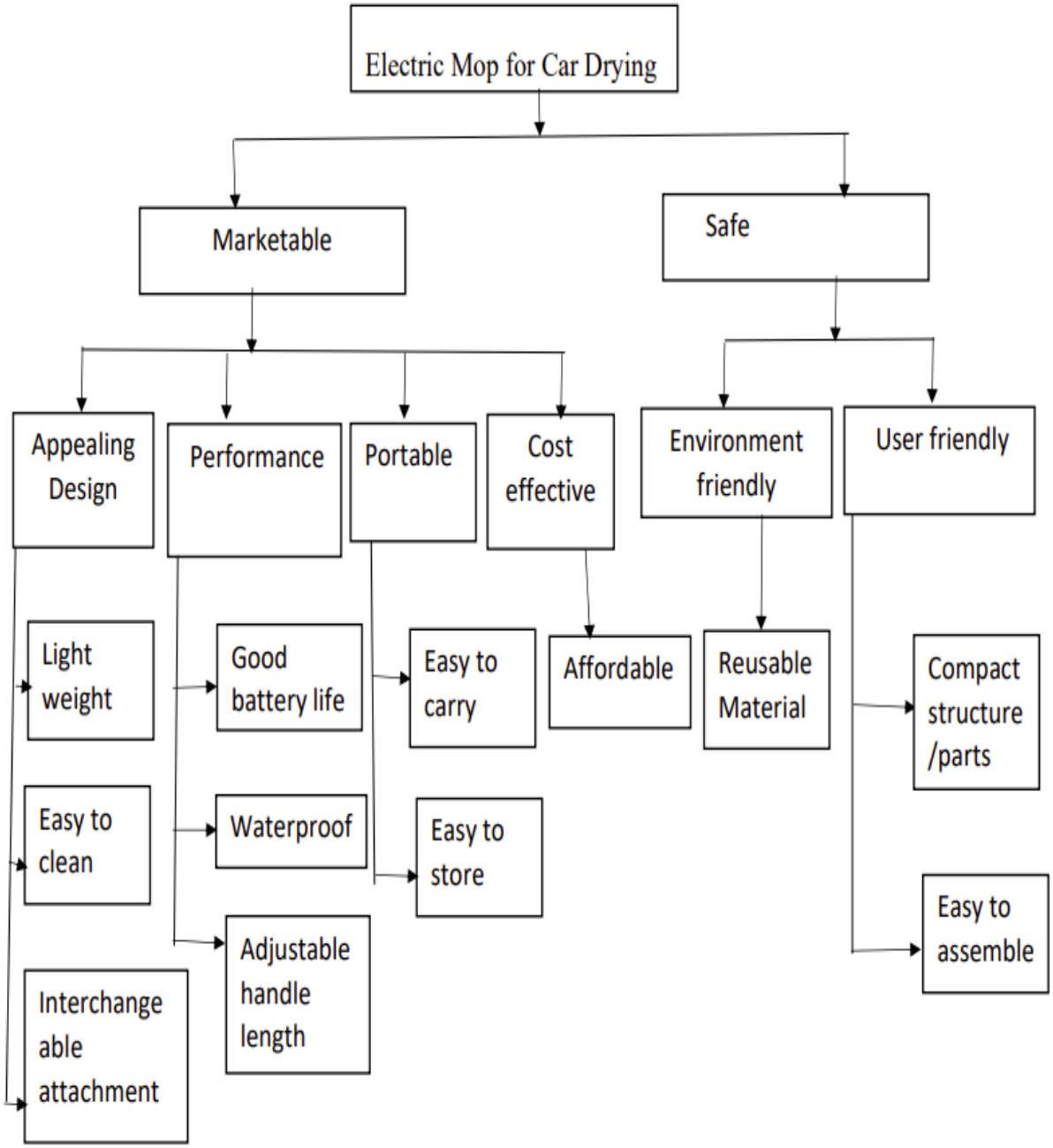

Figure 3: Objective Tree

3.2 Pairwise Comparison of Objectives

This tool orders the relative importance of the objectives. With customer perspective, the following pairwise comparison chart is shown:

Criteria	Appealing Design	Performance	Cost effective	Environment friendly	Portable	Score
Appealing Design	X	0	1	1	1	3
Performance	1	X	1	1	1	4
Cost effective	0	0	X	1	1	2
Environment friendly	0	0	0	X	1	1
Portable	0	0	0	0	X	0

Figure 4: Pairwise Comparison

With highest score 4, Performance is the main objective, followed by appealing design with score 3, then cost effective with score 2 and Environment friendly with score 1.

3.3 Function Means Tree

A function–means tree is a graphical representation of a design's basic and secondary functions. The following function means tree is for Electric mop for car drying. The top-level function has been specified in the most general terms possible. At the next level, a manual mop and an electric powered mop are given as two different means. These two means imply different sets of secondary functions, as well as some common ones. Lower levels provide a few of these auxiliary functions and their potential implementations.

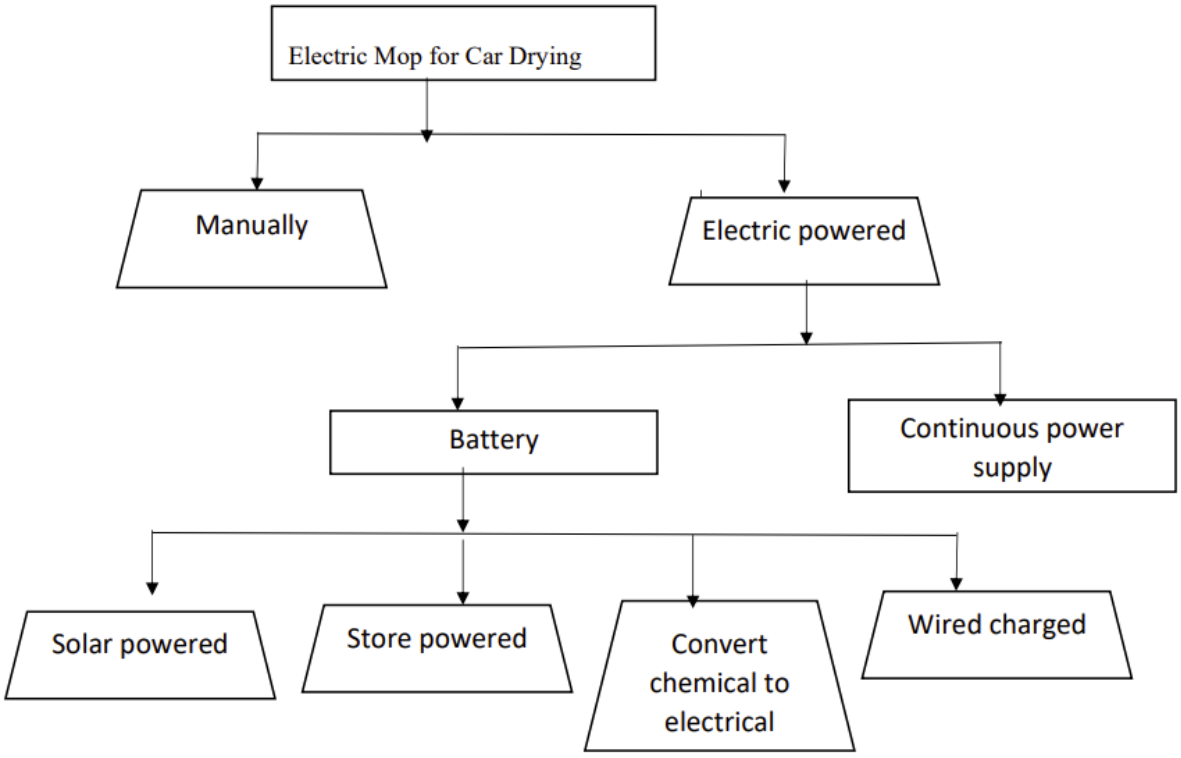

Figure 5: Function Means Tree

4 Analyses

4.1 User need

Most of the individuals view washing an automobile as more of a chore than a success. Cleaning an automobile from top to bottom is frequently compared to punishment rather than enjoyment because it's labor-intensive, time-consuming, and unbearably tedious task. Many gadgets are available for car wash. But when it comes to drying with clean cloth there are limited options available. After washing the car, drying the remaining water droplets is another heavy

task. Introducing an innovative and new product, electric mop for car drying with attached microfiber cloth to a long stick to help car owners with quick clean drying experience of the car.

4.2 Market size

The market for car care products was estimated to be worth USD 10.2 billion in 2021 and is anticipated to increase at a CAGR of 3.6% from 2022 to 2030. The expansion of the automobile industry globally is anticipated to drive the market. The sector is anticipated to expand further as a result of rising disposable income in developing nations and rising customer awareness of the need for car maintenance and repair. The U.S. market for car care products is expected to grow in the coming years on account of the robust growth in the automobile industry. The application scope is what essentially drives the competition.

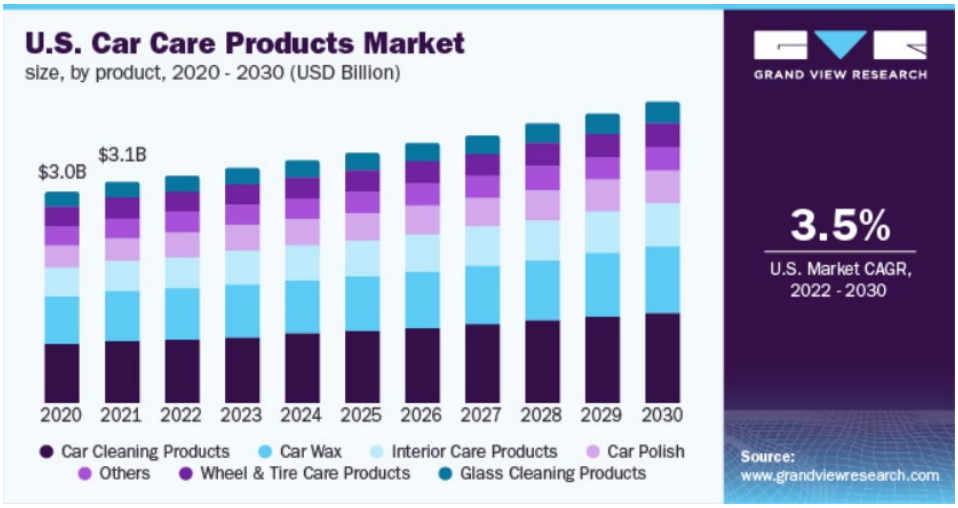

Figure 6: Car Care Market

4.3 Current Competitors

The target customers would be users washing cars at home, semi- automatic car washes. Currently there are numerous companies selling product car wash microfiber cloth mops. But

they are manual and not electrically powered. Major companies are Anngrowy, Ordenado, Leeloon and more. The approximate price range for these products is between $20 - $40 depending on their functionality. The major performance factors are Quality, Design and Easy Use.

5 Design solution

5.1 Description of Functionality

The electrically powered handheld car drying mop will help users to dry the car after washing. The mop will have a long handle with adjustable head angle at the tail end for easy movement during cleaning. At the head, the microfiber mop will be attached to a long handle along with a rechargeable battery. The microfiber mop can be interchanged with chenille microfiber as well. This mop will come with different attachments for cleaning windows, tires. Once the battery is charged, the user can utilize this mop to dry the car after washing by just holding it against the exterior of the car.

5.2 Product specifications

5.2.1 Product information:

Total product dimension:	1943.32 mm * 90 mm
Holder Dimension	131.1*121.14mm
Handle Dimension	365.02mm * 184.07mm

Weight	2 lbs.
Specific use of product:	Car wet cleaning and drying.
From factor	Handheld.

5.2.2 Battery:

Battery Used: PBP002 – Battery

Capacity	1.5Ah
Fuel Gauge	Integrated LEDs
Chemistry	lithium ion
Fuel Gauge	Yes
Uses Charger	P117, P131, P113, P114, and P116 (Sold Separately)

5.2.3 PCL206B - 18V ONE+ 1/2" Drill/Driver

Chuck	1/2"
Clutch	24-position
RPM	0-450 / 0-1,750
Torque	Up to 515 in-lbs.

5.2.4 Head attachment

Material:	Microfiber
Item Type	Mop Head Refill
Shape	Circle
Overall Diameter (Flat):	37cm/14.57inch
Plate Outer Diameter:	16cm/6.30inch
Plate Inner Diameter:	9.4cm/3.7inch
Suitable for:	Spin Mop

Handle Material: Aluminum Alloy.

Materials: Polypropylene, Plastic, Aluminum Alloy.

Features: Long handle, Adjustable head angle, Portable, Easy to use, Compact storage.

5.2.5 Design

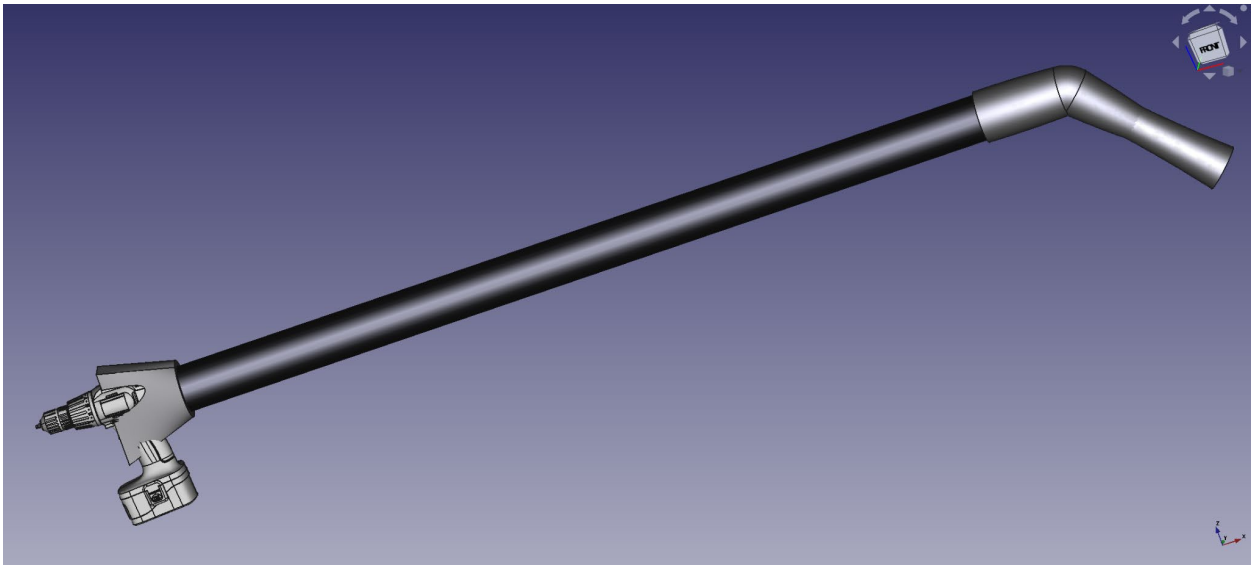

Figure 7: Design of Our Product

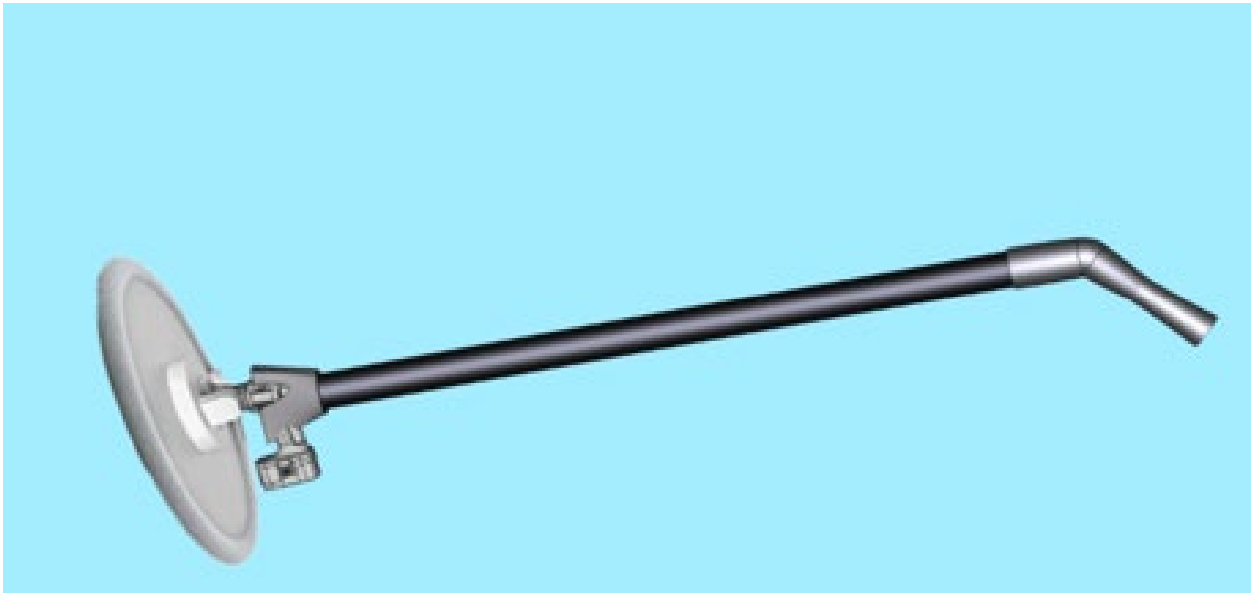

Figure 8: Final Product Design

5.2.6 Design specifications

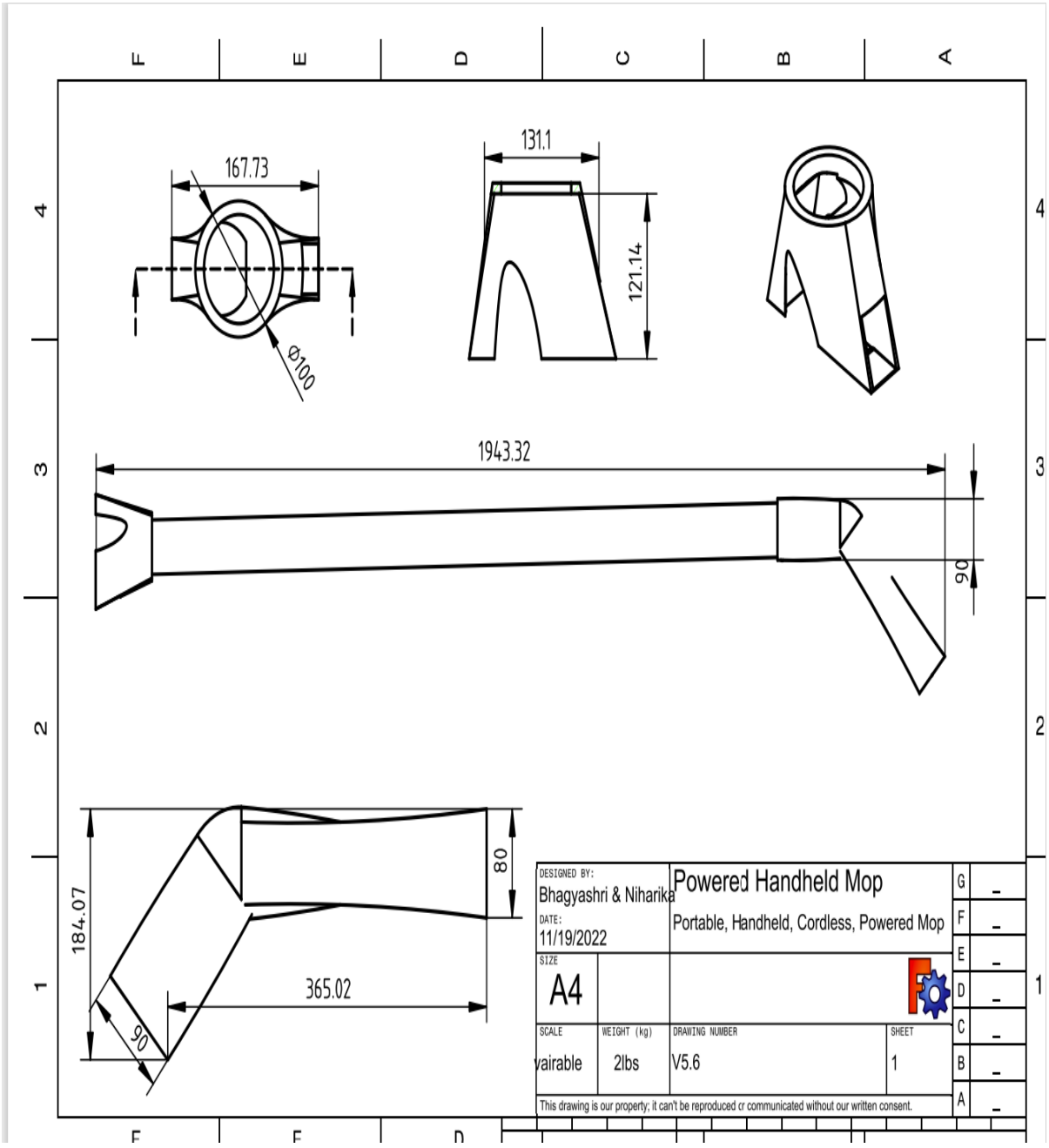

Figure 9: Design Specifications

5.2.7 Process specification

The fabrication/manufacturing process used to produce parts (In -house)

- Holder, Pipe body made with plastic in house.
- Plastic parts begin with computerized drafting and design systems.
- The parts are shaped in a two-part steel mold, called a die that is lowered into the chamber of an injection-molding machine.
- The two halves of the mold open enough to let the plastic part fall into a bin. The plastic hardens on contact with the air as the tool opens. The parts are assembled as per needed.
- The joints, electric motor, battery, microfiber mops bought from manufacturers or wholesalers. These individual components are assembled in-house by employees.

Assembly of the parts:

1)Aluminum Alloy handle and Pipe Body top part attached with press fit method using ball hinge joint.

2)The holder is attached to the motor.

3) The motor and Pipe Body bottom part are attached with a press fit method using a swivel joint.

4) At the end of the motor we can add different cleaning and drying attachments.

6 Cost analysis

The Following table shows estimated cost to produce 100 pieces in 10 days:

	Costs	in $'s		per unit	100 peices in 10 days
	Tooling Cost				
Fixed Cost	Mold Cost (to maker)	$5,000.00			
	Tools for assembly	$2,000.00			
Variable Cost	Labor Cost 3 people for inventory management , assembling parts and packaging. $15 (daily pay/Hr) * 6 hours * 3	$270.00	/day		$2,700.00
	Joints Cost				$9.30
	Swivel Joint	$0.40	/ piece	$0.40	$4.00
	Ball Hinge Joint	$0.53	/piece	0.53	$5.30
	Polypropylene Plastic Cost	$0.90	/6 pieces	$0.15	$1.50
	Aluminum alloy handle cost	$1.40	/12 pieces	$0.12	$1.17
	Electric Motor Cost	$23.00	/each	23	230
	Microfiber Head Cost	$287.28	/ case of 108	$5.32	$53.20
	Packaging Costs	$0.42	/ each	$1	$10
	Miscellaneous	$500.00	/30 days	$16.67	$166.67
			Cost to make 100	**$31.81**	**$3,181.13**
			Selling Price	**$40**	

Figure 10: Cost Analysis

Each unit would cost $31.81 approx. to make. The selling piece is set to $40. Further doing breakeven analysis, it is found that 855 units need to be sold.

Break Even Analysis	
Break Even Point	Fixed Cost / (Selling price per Unit) - (Variable Cost Per Unit)
Units	**854.8400228**

Figure 11: Breakeven Analysis

7 Sustainability Assessment

Life Cycle Analysis of the Product:

1. Raw Materials Extraction (RME)

Materials used: Aluminum, Polypropylene

- Environmental impacts:

  – High Consumption of energy, water

  – Large amounts of solid (bauxite refinery residue (BRR) or red mud) and gas (perfluorocarbon gas and carbon dioxide) residue, some toxic like BRR.

- Design considerations:

  1. Use recycled or recyclable material.

     Recyclable material like Polypropylene plastics, Aluminum alloy to be used.

LCA data chart Ratings Criteria:

Material Choice

0 - reactive, releases harmful emissions

1 - 20-49% non-reactive, non-harmful emissions

2 - 50-80% non-reactive, non-harmful emissions

3 - non-reactive, non-harmful emissions

4 - non-reactive, does not release harmful emissions

Energy Usage

0 - Does not use renewable energy, high energy consumption during extraction

1 - Uses less than 50% renewable energy, high energy consumption during extraction

2 - Uses 50% or more renewable energy, energy efficient with 2 stars

3 - Uses renewable energy sources, energy efficient with 3 stars

4 - Highly energy efficient, low generation of heat

Solid Residual

0 - High amount of solid residual with 0% recyclable material

1 - Medium amount of solid residual with 10 % recyclable materials

2 - Considerable amount of solid residual with 50 % recyclable materials

3 - Little amount of solid residual with 90% recyclable materials

4 - No solid residual material / <5% solid residual with 100% recyclable materials

Liquid Residual

0 - releases harmful liquid residuals which are harmful for environment and living beings

1 - >70% liquid residuals which make liquid pollution and unfit for reuse

2 - releases liquid residuals which cannot be reused but are not harmful

3 - Does not harm environment, > 45% can be reused/recycled

4 - Does not harm environment,100% reused/recycled

Gaseous Residual

0 - releases harmful solid residuals which are harmful for environment and living beings

1 - releases >70% gaseous residuals which are less harmful.

2 - releases <40% gaseous residuals which are less harmful.

3 - non-harmful gaseous residuals released

4 - no emissions of harmful gaseous residuals for the environment, can be reused/recycled.

2. Product Manufacturing and Assembly (PM)

Individual components bought; assembly of those individual components done in-house

- Environmental impacts:

– High Consumption of energy and materials

– Significant amounts of residue, majorly solid wastes.

- Design considerations:

1. Use the appropriate amount of aluminum alloy and polypropylene for making parts of products.

2. Use of energy efficient tools and machines for assembly.

LCA data chart Ratings Criteria:

Material Choice

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2 - releases <40% gaseous residuals which are less harmful.

3 - non-harmful gaseous residuals released

4 - no emissions of harmful gaseous residuals for the environment, can be reused/recycled.

3. Packaging & Transportation (PP&T)

- Environmental impacts:

– Product transportation consumes a large amount of energy

– Packing utilizes numerous small packaging materials, multiple boxes.

- Design considerations:

– Use fully recyclable materials

– Use minimum packaging materials

LCA data chart Ratings Criteria:

Material Choice

0 - reactive, releases harmful emissions

1 - 20-49% non-reactive, non-harmful emissions

2 - 50-80% non-reactive, non-harmful emissions

3 - non-reactive, <10% harmful emissions

4 - non-reactive, does not release harmful emissions, environment friendly

Energy Usage

0 - Does not use renewable energy, high energy consumption during extraction

1 - Uses less than 50% renewable energy, high energy consumption during extraction

2 - Uses 50% or more renewable energy, energy efficient with 2 stars

3 - Uses renewable energy sources, energy efficient with 3 stars

4 - Highly energy efficient, low generation of heat

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2 - releases <40% gaseous residuals which are less harmful.

3 - non-harmful gaseous residuals released

4 - no emissions of harmful gaseous residuals for the environment, can be reused/recycled.

4. Use, Service & Repair (PU)

- Environmental impacts:

– Consumption of energy

- Design considerations:

– Minimum energy consumption during use, energy efficiency

– Reusable / recyclable material for handles, head attachment for repair.

LCA data chart Ratings Criteria:

Material Choice

0 - reactive, releases harmful emissions

1 - 20-49% non-reactive, non-harmful emissions

2 - 50-80% non-reactive, non-harmful emissions

3 - non-reactive, non-harmful emissions

4 - non-reactive, does not release harmful emissions, easy to repair.

Energy Usage

0 - Does not use renewable energy, high energy consumption during extraction

1 - Uses less than 50% renewable energy, high energy consumption during extraction

2 - Uses 50% or more renewable energy, energy efficient with 2 stars

3 - Uses renewable energy sources, energy efficient with 3 stars

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1 - releases >70% gaseous residuals which are less harmful.

2 - releases <40% gaseous residuals which are less harmful.

3 - non-harmful gaseous residuals released

4 - no emissions of harmful gaseous residuals for the environment, can be reused/recycled.

5. Product Disposal (PD)

- Environmental impacts:

– Minimum generation of wastes as polypropylene is fully recyclable, aluminum alloys are recyclable.

- Design considerations:

– Fewer components and material types

– Disassembly is simple.

– Easy value recovery of disposal parts.

LCA data chart Ratings Criteria:

Material Choice

0 - 0% recyclable, concern for landfill.

1 - 20-49% recyclable, degrades at slower rate

2 - 50-80% recyclable, degrades at medium rate

3 - more than 80% recyclable, degrades sooner

4 -100% recyclable

Energy Usage

0 - Does not use renewable energy, high energy consumption during disposal

1 - Uses less than 50% renewable energy, high energy consumption during disposal

2 - Uses 50% or more renewable energy, energy efficient with 2 stars

3 - Uses renewable energy sources, energy efficient with 3 stars

4 - Highly energy efficient, low generation of heat

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Overall Ratings in each phase is denoted as below:

	MC	EU	SR	LR	GR
RME	**0**	**1**	**0**	**1**	**0**
PM	**2**	**2**	**2**	**3**	**3**
PP&T	**3**	**2**	**3**	**4**	**2**
PU	**4**	**3**	**4**	**4**	**4**
PD	**3**	**3**	**3**	**3**	**3**

LCA Data Chart

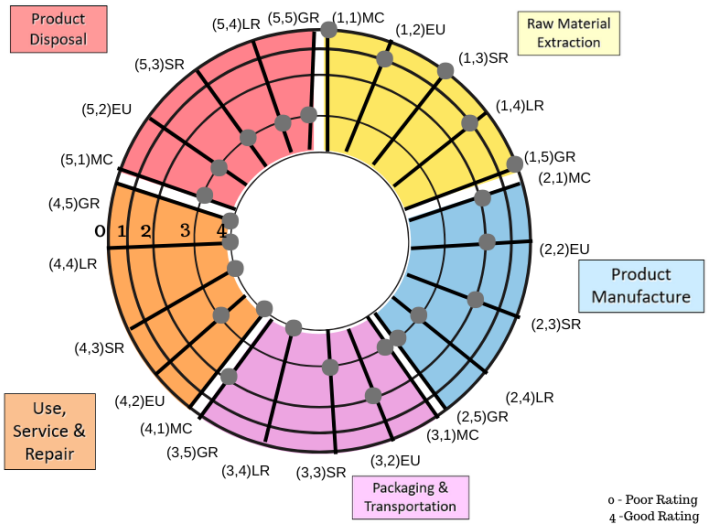

Figure 12: LCA Data Chart

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