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Design Improvement and Cost Reduction of a Hair Dryer: A DFMA and Value Engineering Approach

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Abstract

This paper focuses on evaluating the performance of the original hair dryer in terms of cost and design efficiency and proposes modifications and improvements through integrated DFMA (Design for Manufacture and Assembly) and Value Engineering analyses. Grounded in the DFMA theory, the objective is to obtain the most cost-effective products and production methods while simplifying the manufacturing process. The optimization of the hair dryer's configuration aims to enhance speed and affordability in both construction and assembly. Through the elimination of certain components, the improved design not only reduces the difficulty of manufacturing but also lowers production costs. The methodology involves a comparative performance analysis between the original and improved designs, utilizing both DFMA and VE principles. Six significant improvements, informed by these methodologies, contribute to a 3% enhancement in design efficiency—from 59% to 62%. This enhanced design demonstrates notable progress in assembly efficiency, parts reduction, cost-effectiveness, and overall design efficiency. The findings provide valuable insights for the development of improved designs and cost-reduction strategies in the context of hair dryer manufacturing.

1. Introduction

Design for Manufacture and Assembly (DFMA) and Value Engineering are two well-known approaches to product development and cost cutting. DFMA provides a strong emphasis on optimizing the design and production processes to improve the efficiency of product assembly and manufacture, which ultimately reduces costs [1]. Value engineering, on the other hand, adopts an integrated approach that aims to maximize the value of a product or process by examining functions, investigating alternative approaches, and spotting chances for cost reduction while preserving or enhancing performance [2].

The hair dryer was fundamentally selected as the product to be studied in this research. A hair dryer is a frequently used electronic device that makes drying and styling hair quick and easy. The use of hair dryers is continuing to grow as consumer quality of life improves and personal image tools become more important [3]. The market for manufacturers has become highly competitive because of the rising demand for hair dryers.

This thesis focuses on how a combined DFMA and Value Engineering strategy can enhance the design and reduce the cost of a hair dryer. By combining these two techniques, the study seeks to identify areas in the design and production of the hair dryer where cost-saving options exist without sacrificing performance or

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quality. The purpose is to create an optimized design that improves the product's value proposition while simultaneously lowering production costs, which is advantageous to both producers and customers.

1.1 Design for Manufacture and Assembly (DFMA)

Design for Manufacture (DFM) and Design for Assembly (DFA) are the two components of DFMA. Design for Manufacture (DFM) considerations guarantee that there are as few jigs and fixtures, cutting tools, stack ups of tolerance, and mismatched assemblies as possible. To identify and address manufacturing issues while the product is being created, the DFM approach involves taking design goals and manufacturing restrictions into consideration concurrently. This helps to cut down on lead times and improve product quality. In product design, Design for Manufacture (DFM) analysis can be done manually. Specifically, for the DFM concurrent costing, it can be used to determine the cost per part of the hair dryer and it can be used in SolidWorks software.

Design for Assembly (DFA) strategies focus on reducing the product's components count through the deletion or integration of parts and the reduction of part variants, which enhances product quality and reduces assembly issues. Parts count reduction reduces unused manufacturing and assembly costs in product development. When a product has fewer parts, less space is needed to manufacture it. The designers can identify product families and employ standard components because of the parts variant reduction, which has the advantages of a common assembly process and lower tooling and storage costs. DFA makes the product simpler by using fewer parts, and the assembly is quicker and easier to make [4] [5].

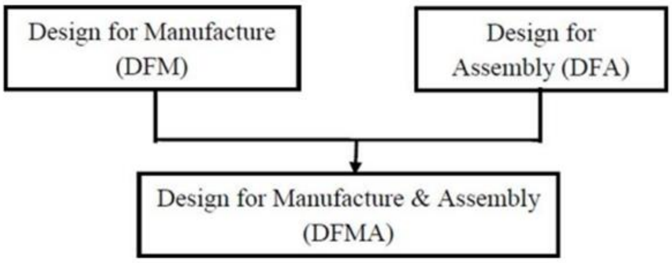

Fig. 1 *Definition of Design for Manufacture and Assembly (DFMA)* **[1]**

1.1.1 Stages in design process

Application of DFMA in product design: When DFMA is used in the design process, the following stages are taken.

1. DFA analysis leading to product structure simplification.
2. Early component cost estimation for both the original and modified designs.
3. Choosing the appropriate method and material to employ.
4. Complete a detailed examination of DFM after deciding the choice of material and process.

1.2 Value Engineering

The ratio of "what you get" (function) to "what it costs" (resource) is used in value engineering to define value [6]. It begins by identifying the product's components and the functions these components perform. To find potential areas for improvement, the costs and values of these parts and functions are compared. This could lead to the development of a new product or the adaptation of an existing one [7]. VE focuses on the derivation of measures and their inventive implementation to increase the value of a product.

Value engineering technique involves a few steps. Mr. Nigel Grass has broken down a product's components and noted which functions are performed by each one. The costs of the components and the values of each identified function for the customer are then calculated. Potential for improvement can be found and maximized in the processes of developing new products or adapting existing products using the costs for the components and the value of the functions [8]. This is a creative process that raises the value of a product by maximizing the relationship between the product's function and cost. It is a very effective way to improve the value of the product and its innovation design to incorporate the concepts and techniques of value engineering into the product design [9] [10].

1.3 Hair Dryer

A hair dryer, commonly referred to as a blow dryer, is an electric tool used to dry and style hair. Wet hair is helped to evaporate by the warm air when it hits it. To create various hair styles, hair dryers can be used with a range of brushes and combs. Around 1945, electric hairdryers first became generally accessible. Since then, not much has changed in how they perform their function: an electric motor drives a fan, which then forces air through heating components before being pushed onto the hair through a nozzle. They were big and heavy, made of pressed steel sheet or zinc die castings. The "metal mentality" that dominated their work was evident in the various fasteners used to assemble parts that could be easily cast, pressed, and machined. Internal insulation was required since metals conduct both heat and electricity, protecting the user from burns or electrocution. This contributed to the device being bulky, as did the use of ineffective motors and fans [11].

2. Materials and Methods

2.1 Manual DFA Analysis

The DFA analysis focuses on assessing assembly simplicity and finding opportunities for simplifying the assembly procedure. Step to do during the DFA manual analysis is as follows:

1. Disassembled component and parts description.
2. Evaluation of the assembly process by Boothroyd Dewhurst Method.
3. Definition and improvement of the parts proposed.
4. Evaluation of modified parts by Boothroyd Dewhurst Method.
5. Evaluation of original and improved parts.

2.1.1 Boothroyd Dewhurst Method

The use of the DFA worksheet table as shown in Figure 2 was used to evaluate the assembly using the Boothroyd method in this study. The method for evaluating the DFA worksheet is as follows:

I. The component's specifications and quantity:
The part's dimension and quantity were measured, and the information was then entered onto the DFA worksheet.

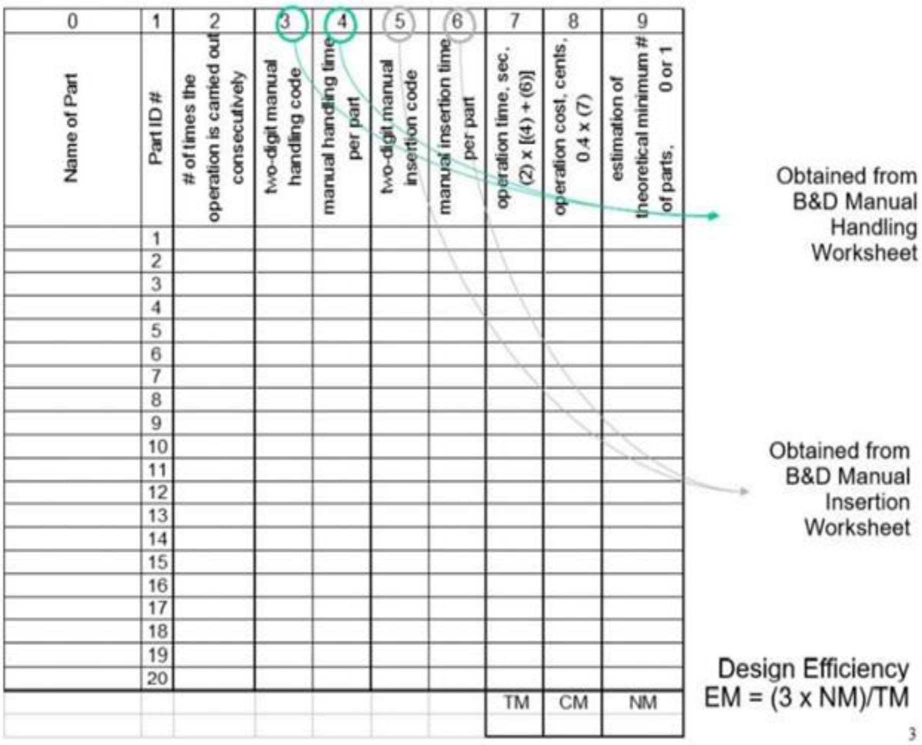

Fig. 2 *DFA Worksheet* [1]

II. Determining how each part's symmetry affects each part:
The symmetry balance while handling is crucial for the assembly process. There are two different kinds of symmetry: alpha symmetry and beta symmetry. Figure 3 shows the rotation of the alpha symmetry and demonstrates how it is rotated at an angle to the axis of rotation. Rotation about the axis of insertion is seen to be slower in comparison to beta symmetry rotation on the axis of insertion in Figure 4.

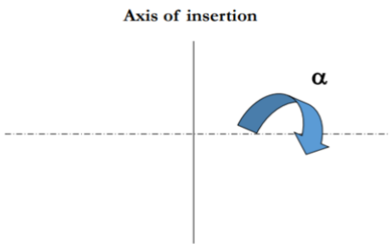

Fig. 3 *Alpha symmetry rotation* [1]

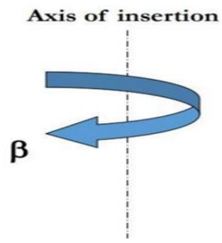

Fig. 4 *Beta symmetry rotation* [1]

III. Manual handling worksheet evaluation:

As shown in Figure 5, the two-digit handling code and the time required for manual handling of each piece are obtained by manual handling using the handling symmetries.

MANUAL HANDLING-ESTIMATED TIMES (s)

Key: One hand — Parts can be grasped and manipulated by one hand without the aid of grasping tools

		Parts are easy to grasp and manipulate					Parts present handling difficulties (1)				
		Thickness >2 mm			Thickness ≤2 mm		Thickness >2 mm			Thickness ≤2 mm	
		Size >15 mm	6 mm ≤ size ≤15 mm	Size <6 mm	Size >6 mm	Size ≤6 mm	Size >15 mm	6 mm ≤ size ≤15 mm	Size <6 mm	Size >6 mm	Size ≤6 mm
		0	1	2	3	4	5	6	7	8	9
(α+β) < 360°	0	1.13	1.43	1.88	1.69	2.18	1.84	2.17	2.65	2.45	2.98
360° ≤ (α+β) < 540°	1	1.5	1.8	2.25	2.06	2.55	2.25	2.57	3.06	3	3.38
540° ≤ (α+β) < 720°	2	1.8	2.1	2.55	2.36	2.85	2.57	2.9	3.38	3.18	3.7
(α+β) = 720°	3	1.95	2.25	2.7	2.51	3	2.73	3.06	3.55	3.34	4

One hand with grasping aids — Parts can be grasped and manipulated by one hand but only with the use of grasping tools

			Parts need tweezers for grasping and manipulation								Parts need standard tools other than tweezers	Parts need special tools for grasping and manipulation
			Parts can be manipulated without optical magnification				Parts require optical magnification for manipulation					
			Parts are easy to grasp and manipulate		Parts present handling difficulties (1)		Parts are easy to grasp and manipulate		Parts present handling difficulties (1)			
			Thickness >0.25 mm	Thickness ≤0.25 mm	Thickness >0.25 mm	Thickness ≤0.25 mm	Thickness >0.25 mm	Thickness ≤0.25 mm	Thickness >0.25 mm	Thickness ≤0.25 mm		
			0	1	2	3	4	5	6	7	8	9
α ≤ 180°	0 ≤ β ≤ 180°	4	3.6	6.85	4.35	7.6	5.6	8.35	6.35	8.6	7	7
α ≤ 180°	β = 360°	5	4	7.25	4.75	8	6	8.75	6.75	9	8	8
α = 360°	α ≤ β ≤ 180°	6	4.8	8.05	5.55	8.8	6.8	9.55	7.55	9.8	8	9
α = 360°	β = 360°	7	5.1	8.35	5.85	9.1	7.1	9.55	7.85	10.1	9	10

Two hands for manipulation

		Parts present no additional handling difficulties					Parts present additional handling difficulties (e.g. sticky, delicate, slippery, etc.) (1)				
		α ≤ 180°			α = 360°		α ≤ 180°			α = 360°	
		Size >15 mm	6 mm ≤ size ≤15 mm	Size <6 mm	Size >6 mm	Size ≤6 mm	Size >15 mm	6 mm ≤ size ≤15 mm	Size <6 mm	Size >6 mm	Size ≤6 mm
		0	1	2	3	4	5	6	7	8	9
Parts severely nest or tangle or are flexible but can be grasped and lifted by one hand (with the use of grasping tools if necessary) (2)	8	4.1	4.5	5.1	5.6	6.75	5	5.25	5.85	6.35	7

Two hands or assistance required for large size

		Parts can be handled by one person without mechanical assistance									Two persons or mechanical assistance required for parts manipulation
		Parts do not severely nest or tangle and are not flexible								Parts severely nest or tangle or are flexible (2)	
		Part weight < 10 lb				Parts are heavy (>10 lb)					
		Parts are easy to grasp and manipulate		Parts present other handling difficulties (1)		Parts are easy to grasp and manipulate		Parts present other handling difficulties (1)			
		α ≤ 180°	α = 360°	α ≤ 180°	α = 360°	α ≤ 180°	α = 360°	α ≤ 180°	α = 360°		
		0	1	2	3	4	5	6	7	8	9
Two hands, two persons or mechanical assistance required for grasping and transporting parts	9	2	3	2	3	3	4	4	5	7	9

Fig. 5 *Manual handling worksheet* [1]

MANUAL INSERTION-ESTIMATED TIMES (s)

Key: Part added but not secured

			Alter assembly no holding down required to maintain orientation and location (3)				Holding down required during subsequent processes to maintain orientation at location (3)			
			Easy to align and position during assembly (4)		Not easy to align or position during assembly		Easy to align and position during assembly (4)		Not easy to align or position during assembly	
			No resistance to insertion	Resistance to insertion (5)	No resistance to insertion	Resistance to insertion (5)	No resistance to insertion	Resistance to insertion (5)	No resistance to insertion	Resistance to insertion (5)
			0	1	2	3	6	7	8	9
Addition of any part (1) where neither the part itself nor any other part is finally secured immediately	Part and associated tool (including hands) can easily reach the desired location	0	1.5	2.5	2.5	3.5	5.5	6.5	6.5	7.5
	Part and associated tool (including hands) can not easily reach the desired location: Due to obstructed access or restricted vision (2)	1	4	5	5	6	8	9	9	10
	Part and associated tool (including hands) can not easily reach the desired location: Due to obstructed access and restricted vision (2)	2	5.5	6.5	6.5	7.5	9.5	10.5	10.5	11.5

Key: Part secured immediately

			No screwing operation or plastic deformation immediately after insertion (snap/press fits,circlips,spire nuts,etc.)		Plastic deformation immediately after insertion						Screw tightening immediately after insertion	
					Plastic bending or torsion			Riveting or similar operation				
						Not easy to align or position during assembly			Not easy to align or position during assembly			
			Easy to align and position with no resistance to insertion (4)	Not easy to align or position during assembly and/or resistance to insertion (5)	Easy to align and position during assembly (4)	No resistance to insertion	Resistance to insertion (5)	Easy to align and position during assembly (4)	No resistance to insertion	Resistance to insertion (5)	Easy to align and position with no torsional resistance (4)	Not easy to align or position and/or torsional resistance (5)
			0	1	2	3	4	5	6	7	8	9
Addition of any part (1) where the part itself and/or other parts are being finally secured immediately	Part and associated tool (including hands) can easily reach the desired location and the tool can be operated easily	3	2	5	4	5	6	7	8	9	6	8
	Part and associated tool (including hands) cannot easily reach desired location or tool cannot be operated easily: Due to obstructed accessor restricted vision (2)	4	4.5	7.5	6.5	7.5	8.5	9.5	10.5	11.5	8.5	10.5
	Part and associated tool (including hands) cannot easily reach desired location or tool cannot be operated easily: Due to obstructed access and restricted vision (2)	5	6	9	8	9	10	11	12	13	10	12

Key: Separate operation

		Mechanical fastening processes (part(s) already in place but not secured immediately after insertion)				Non-mechanical fastening processes (part(s) already in place but not secured immediately after insertion)				Non-fastening processes	
		None or localized plastic deformation				Metallurgical processes					
							Additional material required				
		Bending or similar process	Riveting or similar processes	Screw tightening or other processes	Bulk plastic deformation (large proportion of part is plastically deformed during fastening)	No additional material required (e.g. resistance, friction welding, etc.)	Soldering processes	Weld/braze processes	Chemical processes (e.g. adhesive bonding, etc.)	Manipulation of parts or sub-assembly (e.g. orienting, fittings or adjustment of part(s), etc.)	Other processes (e.g. liquid insertion, etc.)
		0	1	2	3	4	5	6	7	8	8
Assembly processes where all solid parts are in place	9	4	7	5	12	7	8	12	12	9	12

Fig. 6: *Manual insertion worksheet* [1]

IV. Manual insertion worksheet evaluation:

The manual insertion worksheet evaluation, as depicted in Figure 6, also made use of the handling symmetries, to determine the two-digit manual insertion and the amount of time required for each part during insertion.

V. Calculating operation time and costs:

The operation time can be calculated by multiplying the quantity of the part by the amount of manual handling and the time required for insertion for each part which based on equation 1. The effectiveness of the design is measured on a scale of 0.4 for the cost of operation. The cost of operation can be calculated by multiplying 0.4 by the number of times each component was used which refer to equation 2.

$$\text{Operation time} = C2(C4+C6) \tag{1}$$

$$\text{Operation cost} = 0.4(C7) \tag{2}$$

Where,

C2= Number of times the operation is carried out consecutively

C4= Manual handling time per part

C6= Manual insertion per time per part

C7= Operation time in second

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2.2 Part Description

While disassembling the chosen project, 17 different parts with a total of 18 units were discovered from the hair dryer and utilized in the research.

Table 1: *Part Description*

No	Part Name	Function	Material	Manufacturing Process
1	Back cover	Enclosure that houses the internal components of the hair dryer.	ABS Plastic	Injection mold
2	Back enclosure cover	Prevent dust and other particles from entering the internal components.	ABS Plastic	Injection mold
3	Back enclosure	Prevent users from coming into direct contact with hot or electrically charged components.	ABS Plastic	Injection mold
4	Speed control knob	Select different levels of airflow.	ABS Plastic	Injection mold
5	Fan blade	Generates airflow within the hair dryer.	Metal	Casting
6	Front enclosure	Directs the flow of air generated by the hair dryer's motor and fan.	ABS Plastic	Injection mold
7	Heat shield	Prevent accidental burns or injuries by ensuring that the external casing of the hair dryer remains at a safe temperature.	Metal	Casting
8	Heater rib 1	Enhance the efficiency of the heating process.	Nichrome wire	Casting
9	Heater rib 2	Enhance the efficiency of the heating process.	Nichrome wire	Casting
10	Heater rib 3	Enhance the efficiency of the heating process.	Nichrome wire	Casting
11	Knob heater	Adjusts the temperature of the airflow produced by the hair dryer.	ABS Plastic	Injection mold
12	Knob top	Activates or deactivates the hair dryer, allowing users to start or stop the airflow.	ABS Plastic	Injection mold
13	Motor housing	Dampen vibrations and reducing the amount of noise produce when motor works.	ABS Plastic	Injection mold
14	Motor	Generate a high-speed airflow.	Metal	Casting
15	Front net	Preventing objects from being drawn into the hair dryer's internal components.	Metal	Casting
16	Part entrance	Allow ambient air to be drawn into the device for the subsequent heating and airflow processes used to dry hair.	ABS Plastic	Injection mold
17	Zig zag heater wire	Generate heat through electrical resistance, allowing the device to produce warm or hot air.	Nichrome wire	Casting

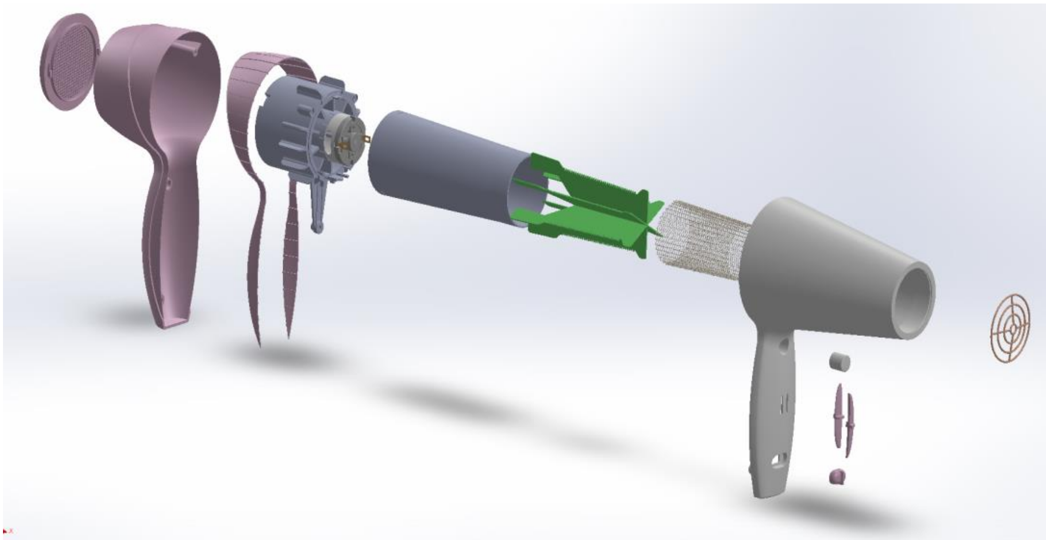


Fig. 7 *3D exploded view of original hair dryer design*

3. Result and Discussion

This section discusses the results of a research that used Value Engineering and Design for Manufacturing and Assembly (DFMA) to improve a hair dryer's design and reduce costs. The results show a more efficient and economical hair dryer by highlighting significant design improvements and cost-cutting strategies. Through systematic study, the analysis aimed to increase the product's overall design efficiency and economic feasibility.

3.1 Manual DFA analysis on original design

The analysis of a hair dryer's original design is displayed in Table 2 below. The DFA table was used in the investigation. The table will produce the original design's operation time, operation cost, and design efficiency.

Table 2 *Boothroyd Dewhurst DFA Evaluation Worksheet of Original Hair Dryer Design*

Part ID	No. of times the operations	Manual handling code	Manual handling time per part	Manual insertion code	Manual insertion time per part	Operation time	Operation cost	Estimation of theoretical minimum number of parts	Part Name
1	1	30	1.95	30	2.0	3.95	1.58	1	Back cover
2	1	32	2.70	30	2.0	4.70	1.88	1	Back enclosure cover
3	1	30	1.95	31	5.0	6.95	2.78	1	Back enclosure
4	2	30	1.95	30	2.0	7.90	3.16	2	Speed control knob
5	1	30	1.95	31	5.0	6.95	2.78	1	Front enclosure
6	1	11	1.80	33	5.0	6.80	2.72	1	Heat shield
7	1	02	1.88	33	5.0	6.88	2.752	1	Zig zag heater wire
8	1	30	1.95	31	5.0	6.95	2.78	1	Heater rib 1
9	1	30	1.95	31	5.0	6.95	2.78	1	Heater rib 2
10	1	30	1.95	31	5.0	6.95	2.78	1	Heater rib 3
11	1	00	1.13	30	2.0	3.13	1.252	1	Knob heater
12	1	00	1.13	30	2.0	3.13	1.252	1	Knob top
13	1	30	1.95	30	2.0	3.95	1.58	1	Motor
14	1	30	1.95	30	2.0	3.95	1.58	1	Motor housing
15	1	30	1.95	30	2.0	3.95	1.58	1	Front net
16	1	30	1.95	30	2.0	3.95	1.58	1	Part entrance
17	1	30	1.95	30	2.0	3.95	1.58	1	Fan blade
TOTAL						90.99 TM	36.40 CM	18 NM	Design Efficiency= 3NM/TM x 100% = 0.59 x100%= 59%

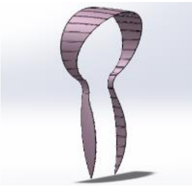
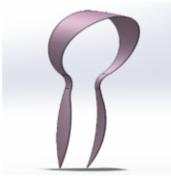
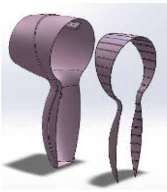
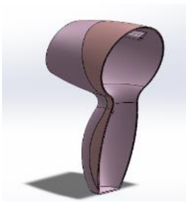
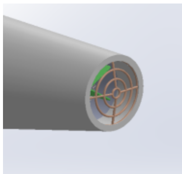
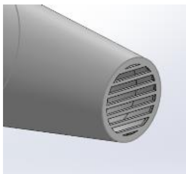
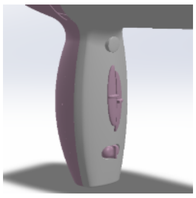
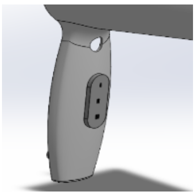
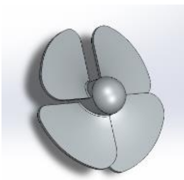
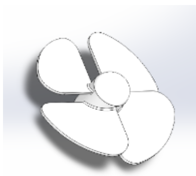
3.1.1 Design efficiency and operation cost of original design

Based on the data on table 2, the total operation time and cost per unit of improved hair dryer design have been determined. The total operation time is 90.99 second and the total operation cost is RM36.40. The design efficiency obtained is 59%.

3.2 Modification proposed on original design

To simplify the hair dryer design, integrate the back enclosure and cover into a single unit using thermoforming or injection molding. Consolidate temperature and speed controls into a single dial. Streamline the air intake grille and front net for cost-effective manufacturing, opting for a single flat surface with fewer vents. Enhance efficiency by using lighter, cost-effective materials like plastic for the fan blade. Keep the back enclosure cover design simple to minimize manufacturing costs. Consider achromatic colours like white or black for a more aesthetically pleasing and cost-effective product design.

Table 3 *Proposed modification on hair dryer*

Parts	Original design	Modified design	Action
Back enclosure cover			Remove the curves or pattern on the surface of the cover, make it more easily and cheaper to manufacture
Back enclosure & back enclosure cover			Combine the back enclosure and back enclosure cover by injection mold to reduce the component of the hair dryer.
Front net			Redesign the front net to be simpler as flat surface and combined to the body of hair dryer.
Speed control knob & knob top & knob heater			Combine the heater knob and top knob into a single piece.
Fan blade			Change the metal fan blade to plastic fan blade.
Colour of hair dryer			Change the colour of hair dryer to black colour.

3.3 Manual DFA analysis on modified design

The analysis of a hair dryer's modified design is displayed in Table 4 below. The DFA table was used in the investigation. The table will produce the modified design's operation time, operation cost, and design efficiency.

Table 4 *Boothroyd Dewhurst DFA Evaluation Worksheet of Modified Hair Dryer Design*

Part ID	No. of times the operations	Manual handling code	Manual handling time per part	Manual insertion code	Manual insertion time per part	Operation time	Operation cost	Estimation of theoretical minimum number of parts	Part name
1	1	30	1.95	30	2.0	3.95	1.58	1	Back cover
2	1	30	1.95	00	1.5	3.45	1.38	1	Back enclosure
3	1	30	1.95	00	1.5	3.45	1.38	1	Speed knob
4	1	30	1.95	30	2.0	3.95	1.58	1	Front enclosure
5	1	11	1.80	33	5.0	6.80	2.72	1	Heat shield
6	1	02	1.88	33	5.0	6.88	2.752	1	Zig zag heater wire
7	1	30	1.95	31	5.0	6.95	2.78	1	Heater rib 1
8	1	30	1.95	31	5.0	6.95	2.78	1	Heater rib 2
9	1	30	1.95	31	5.0	6.95	2.78	1	Heater rib 3
10	1	00	1.13	30	2.0	3.13	1.252	1	Knob top
11	1	00	1.13	30	2.0	3.13	1.252	1	Motor
12	1	30	1.95	30	2.0	3.95	1.58	1	Motor housing
13	1	30	1.95	30	2.0	3.95	1.58	1	Part entrance
14	1	30	1.95	30	2.0	3.95	1.58	1	Fan blade
TOTAL						67.44 TM	26.98 CM	14 NM	Design Efficiency= 3NM/TM x100% =0.623 x 100%= 62%

3.3.1 Design efficiency and operation cost of modified design

Based on the data on table 4, the total operation time and cost per unit of improved hair dryer design have been determined. The total operation time is 67.44 second and the total operation cost is RM26.98. The design efficiency obtained is 62%.

3.4 DFM concurrent costing analysis

The DFM concurrent costing, it can be used to determine the cost per part of the hair dryer and it can be conducted in SolidWorks software. Table 5 shows the comparison of concurrent costing for original and modified design of hair dryer.

Table 5: *Comparison of DFM concurrent costing for original and modified design*

Part no	Hair Dryer Part name	Original Design Quantity	Original Design Total cost, RM	Improved Design Quantity	Improved Design Total cost, RM
1	Back cover	1	4.03	1	4.03
2	Back enclosure cover	1	5.02	0	0
3	Back enclosure	1	4.13	1	8.08
4	Speed control knob	2	7.00	1	6.00
5	Front enclosure	1	5.90	1	6.17
6	Heat shield	1	6.23	1	6.23
7	Zig zag heater wire	1	9.15	1	9.15
8	Heater rib 1	1	5.81	1	5.81
9	Heater rib 2	1	5.81	1	5.81
10	Heater rib 3	1	5.81	1	5.81
11	Knob heater	1	6.00	0	0
12	Knob top	1	3.00	1	3.00
13	Motor	1	15.05	1	15.05
14	Motor housing	1	14.07	1	14.07
15	Front net	1	5.75	0	0
16	Part entrance	1	5.08	1	5.08
17	Fan blade	1	8.65	1	4.50
	Total	18	RM 116.49	14	RM 98.79

(red)	Eliminate	(green)	Modify

3.5 Discussion

After undergoing a redesign, the hair dryer's original design which had 17 separate parts total 18 units was simplified to have 14 distinct parts total 14 units. In connection with the DFMA technique, the fewer parts meant an easier assembly procedure and a significant drop in assembly costs for the better designed product. Using Boothroyd Dewhurst DFA manual analysis, the original and improved designs were analysed. The results showed that the original design had an efficiency of 59%, an operating time per unit of 90.99 seconds, and an associated cost of RM36.40. With an operational efficiency of 62%, the improved design also showed a reduction in running costs of RM9.42 and operation time of 23.55 seconds. This demonstrates the beneficial effects of the design improvements on both the assembly procedure and overall operational effectiveness. Furthermore, based on an analysis of the economic environment, the DFM concurrent cost for the original hair dryer design was RM116.49, but the updated design showed a concurrent costing decrease to RM98.79. The improved design's increased manufacturability and the possibility of manufacturing process cost savings are both highlighted by this economic study.

4. Conclusion

This thesis aimed to evaluate and enhance the cost and design efficiency of a hair dryer through integrated DFMA (Design for Manufacture and Assembly) and Value Engineering analyses. The study successfully optimized the existing design, reducing total assembly time by an impressive 25.88%, from 90.99 to 67.44 seconds, and decreasing the number of different parts by 17.65%, from 17 to 14. This led to a streamlined and efficient assembly process, accompanied by a substantial 22.22% reduction in the total number of parts. The resulting design not only simplified manufacturing logistics but also lowered total assembly costs by 25.88%, from RM36.40 to RM26.98. Additionally, the application of Value Engineering, exemplified by transitioning the fan blade material from metal to ABS plastic and introducing a new black colour scheme, contributed to both structural improvements and market appeal without compromising functionality. The multifaceted progress showcased a 15.19% decrease in concurrent costing, emphasizing the enhanced manufacturability and cost-effectiveness of the improved design. The successful integration of DFMA and Value Engineering methodologies not only optimized the hair dryer's assembly efficiency, cost-effectiveness, and design efficiency but also aligned the product with contemporary market trends, demonstrating a holistic approach to design improvement and cost reduction.

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