DESIGN A LOW COST HAIR DRYER USING DFMA ANALYSIS

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DECLARATION

I declare that this project report entitled "Design a Low Cost Hair Dryer Using DFMA Analysis" is the result of my own work except as cited in the references.

Signature : .....

Name : KOH SHENG YI

Date : 13.06.2017

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovation).

Signature : .....

Name of Supervisor : .....

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DEDICATION

To my beloved mother and father

ABSTRACT

The aim of this project is to design a low cost hairdryer using Design for Manufacturing and Assembly (DFMA). DFMA is an analysis method that consists of two parts, i.e. Design for Manufacturing (DFM) and Design for Assembly (DFA). DFMA analysis is a systematic philosophy that can be applied at the early stage of design. It can helps designers to reduce the number of part count of a product. By applying DFMA in design stage, the design efficiency of a product can increase. In another words, the design of a product can be more efficient. Applying DFMA analysis in the product designing process can also reduce the total number of part count of a product. Hence, the total assembly time and the total manufacturing cost of a product can be reduced. In this project, two different brands of hairdryer Khind and Elba are selected to be analysed using DFMA. The DFA index of Khind and Elba are found to be 0.1059 and 0.1757 respectively. The product with higher DFA index is chosen for modification and improvement in order to achieve an even higher DFA index. Some improvements have been made to Elba hairdryer. For example, the fastening method of the hairdryer had changed from screw fastening to snap-fit fastening method. The design efficiency of the hairdryer increase from 0.1757 to 0.3003. The objective of the project has achieved.

ABSTRAK

Tujuan projek ini adalah untuk mereka bentuk pengering rambut yang berkos rendah menggunakan Design for Manufacturing and Assembly (DFMA). DFMA adalah satu kaedah analisis yang terdiri daripada dua bahagian, iaitu Design for Manufacturing (DFM) dan Design for Assembly (DFA). Analisis DFMA adalah falsafah yang sistematik yang boleh digunakan pada peringkat awal reka bentuk. Ia boleh membantu pereka untuk mengurangkan jumlah bahagian dalam sesuatu produk. Dengan menggunakan DFMA dalam peringkat reka bentuk, kecekapan reka bentuk produk boleh ditingkatkan. Dalam erti kata yang lain, reka bentuk produk boleh menjadi lebih cekap. Menggunakan analisis DFMA dalam proses mereka bentuk produk juga boleh mengurangkan jumlah bahagian dalam produk. Oleh itu, jumlah masa pemasangan dan jumlah kos pengeluaran produk boleh dikurangkan. Dalam projek ini, dua pengering rambut yang berbeza jenama, Khind dan Elba telah dipilih untuk dianalisis menggunakan DFMA. DFA indeks Khind dan Elba didapati adalah 0.1059 dan 0.1757. Produk yang mempunyai indeks DFA yang lebih tinggi dipilih untuk pengubahsuaian dan penambahbaikan bagi mencapai indeks DFA yang lebih tinggi. Beberapa penambahbaikan telah dibuat untuk pengering rambut Elba. Sebagai contoh, kaedah penyambungan pengering rambut telah diubah daripada penyambungan skru kepada snap-fit. Kecekapan reka bentuk pengering rambut meningkat dari 0.1757 ke 0.3003. Objektif projek ini telah dicapai.

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LIST OF ABBREVIATION

3D	3-dimensional
AEM	Assembly Evaluation Method
BDI	Boothroyd Dewhurst, Inc.
CAD	Computer Aided Design
DFA	Design for Assembly
DFE	Design for Environment
DFM	Design for Manufacture
DFMA	Design for Manufacture and Assembly
DFR	Design for Reliability
DFS	Design for Serviceability
FDM	Fused Deposition Modelling
HSM	High Speed Machining
IDA	Institute of Defense Analyse
QFD	Quality Function Development
R&D	Research and Development
SPF	Superplastic Forming
UK	United Kingdom

LIST OF SYMBOLS

E	Assemblability evaluation score ratio
E_{ma}	Design efficiency of the design
K	Assembly cost ratio
N_{min}	Theoretical minimum number of parts
t_a	Basic assembly time for one part
t_{ma}	Estimated time to complete the assembly of the whole product

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Design for Manufacture and Assembly (DFMA) is a fusion of Design for Manufacture (DFM) and Design for Assembly (DFA). The word "manufacture" in this extend represents the fabrication of the individual component or part of a product; whereas the word "assembly" represents the addition or joining process of a few components to form a complete product. DFM has a long history. It dates back to the early 18th century when a Frenchman named LeBlanc concocted the concept of substitutable parts in the manufacturing of muskets which formerly were individually handmade. DFM is a development practice that emphasise on manufacturing issues throughout product development process (Karl et al., 2000). In another word, it is a practice that ease the manufacturing process of the assemblage of components that will become a final product after assembly. Without sacrificing the quality of the product, a successful DFM can results in lower production cost. It involves application of part-forming models such as basic rules, analytic formulas, complex process finite element process simulations (Kevin et al., 2003).

Similarly, the concept of DFA is not new. In the late 20th century, an American professor, Geoff Boothroyd developed the DFA method. DFA aims to make assembly directions and methods simpler. It is used to estimate the manual assembly time and assembly cost of the product on an automatic assembly machine (Boothroyd et al., 1980). The decrement of the number of separate components in a product is the most important factor in reducing the assembly cost. Therefore, some simple criteria were introduced by

Boothroyd in order to ease the combination and elimination of unnecessary parts in a product. These criteria are significantly important for performing a successful DFA analysis.

In this era of globalisation, DFMA is used in concurrent engineering studies to provide solutions to the designers in reducing manufacturing time and assembly cost as well as to quantify improvements. It can also be used as a bench marking tool to study competitors' products and as a "should-cost tool" to assist in supplier negotiations (Boothroyd et al., 2002). Products designed using DFMA analysis will have better quality, reliability and durability compared to traditionally designed products. It reduces the transition time from design phase to the production phase by making the transition process is as smooth and fast as possible. There are many principles of DFMA that can be applied in mechanism design in order to reduce the manufacturing time and assembly cost, for example, by minimising the number of surfaces, eliminating interfaces, optimising the manufacturing process and etcetera. Figure 1.1 shows the definition of Design for Manufacture and Assembly (DFMA).

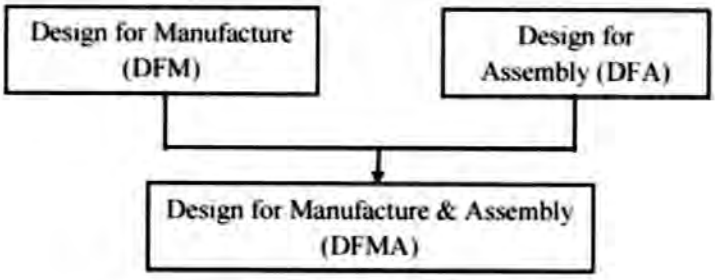

Figure 1.1: Definition of Design for Manufacture and Assembly (DFMA)

The objective of this project is to optimise the designs of two different brands of hairdryers. The new hairdryer proposed after optimisation should have higher quality, lesser number of parts and lower manufacturing costs. Therefore, DFMA analysis is the most suitable method that can be used to improve the design of the products chosen. This project

focuses on the optimisation of the hairdryer design, comparisons of design efficiencies for existing and new design and etcetera. DFMA, DFM and DFA analysis will be discussed in the following chapters. All 3D drawings for existing and new designs will be included in this project.

1.2 PROBLEM STATEMENT

Contrary to the past, the designs of hairdryers nowadays tend to be more and more complex. The complexity of the hairdryers had led to a higher manufacturing cost and assembly time. Most of the hairdryers available in the market serve the same function, though, most of them are over-designed. Manufacturing industries in this era of globalisation mainly focus on mass production concept. All products are required to be manufactured in large quantity and short time. The manufacturing cost and assembly time for over-designed products will be unnecessarily high and long. In this case, over-design products disobey the mass production concept. Therefore, analysis using DFMA principle need to be done during the product design stage in order to produce a competitively priced, high performance product at a minimal cost and time.

1.3 OBJECTIVES

The objectives of this project are as follows:

i. To analyse the design efficiency and to make comparisons between two different brands of low cost hairdryer.

ii. To suggest improvement for a new hairdryer design.

1.4 SCOPE OF PROJECT

The scopes of this project are:

i. Two selected hairdryers will be dismantled, each and every parts of the hairdryers will be drawn using 3D drawing software.

ii. Comparisons on the design efficiency of both the hairdryers will be done using DFMA analysis.

iii. Improvements for a new hairdryer design will be proposed, 3D drawing of the new designed hairdryer will be produced.

iv. Only two hairdryers are selected for comparison in this project due to limited time and cost.

CHAPTER 2

LITERATURE REVIEW

This chapter describes Design for Manufacture and Assembly (DFMA), Design for Assembly (DFA) and Design for Manufacture (DFM) in detail. The history of DFA, DFM and DFMA as well as types of evaluation method are discussed. Several case studies are also reviewed in this chapter.

2.1 Design for Manufacture and Assembly (DFMA)

Before 1940's, Ford and Chrysler had applied DFM analysis in the innovation and manufacturing process of weapons as well as tanks (Xie, 2003). At the beginning of 1970's, Dr. Geoffrey Boothroyd and Dr. Peter Dewhurst did a research on the new DFMA philosophy for product design optimisation and then in 1982, Boothroyd Dewhurst, Inc. (BDI) was founded (Boothroyd et al., 2002). "DFMA" is a trademark of Boothroyd Dewhurst, Inc. (BDI).

DFM is a method that can be used to reduce manufacturing cost of a product by optimising the materials and manufacturing processes. DFA is a method that is used to reduce the assembly cost of a product by reducing the labour assembly time of the product and at the same time, reduce the complexity of the product. Often, DFM and DFA methods are used together to achieve effective results in optimising the design of a product. This combination of DFM and DFA is known as Design for Manufacture and Assembly (DFMA) method. DFMA method aims to minimise the production cost of a product by reducing the number of part count and by utilising the use of manufacturing processes. It is a systematic