DESIGN A LOW COST BREAD TOASTER USING DFMA METHOD

THAM WAI TENG

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STUDENT'S DECLARATION

I declare that this project report entitled "Design a low-cost bread toaster using DFMA method" is the result of my own work except as cited in the references

Signature : ...Thamwaiteng...

Name : ...THAM WAI TENG...

Date : ...12/6/2017...

SUPERVISOR'S DECLARATION

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 & Innovation).

Signature :. ....

Name of Supervisor : Dr Ahadlin bin Mohd Daud

Date : 12/06/2017

DR. MOHD AHADLIN BIN MOHD DAUD
Pensyarah Kanan
Fakulti Kejuruteraan Mekanikal
Universiti Teknikal Malaysia Melaka

DEDICATION

To my beloved mother and father

ABSTRACT

This project is aimed to design a low-cost bread toaster by using Design for Manufacturing and Assembly (DFMA) method. DFMA is a combination Design for Assembly (DFA) and Design for Manufacturing (DFM). It is a well-known systematic approach that used by concurrent engineering to improve the design efficiency, reducing the total cost and total assembly time. This can be achieved by minimizing the number of parts and simplifying the design of parts. Two different brands of bread toaster are selected and compared by using DFMA method. The detailed drawing, assembly view and exploded view of both existing bread toaster are done by Autodesk Inventor. The design efficiency for Pensonic PT-924 and Hanabishi HA-558 is 16.37%% and 17.18% respectively. The results show that Hanabishi HA-558 has higher design efficiency. Hence, a new design is proposed based on Hanabishi HA-558 bread toaster. The new design is designed based on DFMA guidelines. The new design bread toaster consists of 42 parts whereas 19 of them are theoretical minimum part count. The assembly time had reduced from 436.64s to 246.80s. The design efficiency of the new design bread toaster is 23.10%, where it has a 34.63% of increment compared to Hanabishi HA-558. The overall results show that the new design bread toaster has the highest design efficiency and lowest assembly time compared to the both existing bread toaster. It once again proved that DFMA had successfully improved the design efficiency and reduced the assembly time. In results, the objectives of this report are achieved.

ABSTRAK

Projek ini adalah bertujuan untuk mereka satu pembakar roti dengan menggunakan kaedah Design for Manufacturing and Assembly (DFMA) method. DFMA adalah satu combinasi Design for Assembly (DFA) dan Design for Manufacturing (DFM). Ia merupakan salah satu teknik yang terkenal dan sistematik yang diggunakan oleh para jurutera untuk meningkatkan kecekapan reka bentuk, mengurangkan kos dan masa pemasangan. Ini dapat dicapai dengan mengurangkan jumlah komponen dan meringkaskan reka bentuk komponen. Dua pembakar roti dari jenama berlainan telah dipilih dan berbanding menggunakan kaedah DFMA. Semua lukisan pembakar roti adalah dihasilkan dengan Autodesk Inventor. Peratus reka bentuk bagi Pensonic PT-924 dan Hanabishi HA-558 adalah 16.37%% dan 17.18%. Keputusan menunjukkan bahawa Hanabishi HA-558 mempunyai kecekapan reka bentuk yang lebih tinggi. Oleh itu, reka bentuk pembakar roti yang baru dihasilkan berdasarkan pembakar roti Hanabishi HA-558. Reka bentuk pembar roti direka berdasarkan garis panduan DFMA. Reka bentuk yang baru mempunyai 42 komponen sedangkan 19 daripadanya adalah komponen kiraan teori. Masa pemasangan telahpun megurang daripada 436.64 saat kepada 246.80 saat. Kecekapan reka bentuk bagi reka bentuk pembakar roti yang baru adalah 23.10%, di mana ia mempunyai peningkatkan sebanyak 34.63% berbanding dengan Hanabishi HA-558. Secara keseluruhannya, reka bentuk yang baru mempunyai kecekapan reka bentuk yang paling tinggi and masa pemasangan yang paling rendah berbanding dengan kedua-dua pembakar roti tersebut. Ia sekali lagi membuktikan DFMA telah berjaya meningkatkan kecekapan reka bentuk dan mengurangkan masa pemanasanga. Dengan ini, objektif projek ini telahpun dicapai.

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LIST OF ABBRIEVIATIONS

3D	Three Dimensional
AEM	Assembly Evaluation Method
CAD	Computer-Aided Drafting
CE	Concurrent Engineering
DFA	Design for Assembly
DFM	Design for Manufacturing
DFMA	Design for Manufacturing and Assembly
HSM	High Speed Machining
PDS	Product Design Specification
PLC	programmable controller
SPF	Superplastic forming
UTeM	Universiti Teknikal Malaysia Melaka

LIST OF SYMBOLS

NM	Theoretical minimum number of parts
ta	Basic assembly time for one part
TM	Estimated time to complete the assembly of the whole product
E	Assemblability evaluation score ratio
K	Assembly cost ratio

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Nowadays, the most critical challenges faced by manufacturers are to improve the performance of the product by reducing the production cost and manufacturing time. Design for Manufacturing and Assembly (DFMA) is a technique used by concurrent engineering in the early design stage.

Bread toaster, also known as toast maker, is a common household electric device. Bread toaster is used to brown slices of bread by exposing them to radiation of heat until the toasts are ready. There are several types of bread toaster available in the market such as pop-up toaster, toaster oven, and conveyor toaster. The bread toaster selected for this project is pop up bread toaster. This is because the pop-up toaster is most common bread toaster used in the house with affordable price.

DFMA can define as a set of guidelines used in designing a product to increase the efficiency of the manufacturing process and enhance the assembly process with minimum effort, time and cost (AT & T, 1993). In the other word, DFMA analysis is used to produce a design that can be manufactured and assembled easily and low cost. DFMA is a combination of Design for Manufacturing (DFM) and Design for Assembly (DFA).

According to Boothroyd et al. (1994), Design for Assembly (DFA) is a method of designing a product for ease of assembly. The goal of DFA is to reduce the product assembly cost and time by focusing on the part counts, handling difficulties, insertion difficulties, and symmetry. Meanwhile, Design for Manufacturing (DFM) is defined as a method of designing a product for ease of manufacturing (Boothroyd et al., 1994). DFM concerned about reducing overall production cost by minimizing the complexity of parts, selecting the most cost effective material and manufacturing process.

In order to produce a high quality, reliability, and durability products, an analysis using DFMA method is carried out. This is because it ensures a smooth and fast transition start from the early design stage to the production stage by providing an organized way for analyzed a proposed design from assembly and manufacturing aspects. There are many principles of DFMA for mechanical design, such as, reduce the part count, make parts multi-functional, simplify and optimize the manufacturing process, facilitate parts handling and so on.

1.2 PROBLEM STATEMENT

There are several problems regarding this project that need to take note. The household electric appliance involved in this case study is pop up bread toaster. Although the appearance of a bread toaster is simple, it still required high manufacturing cost and assembly time. This is because most of the bread toaster designs available in the market are over-designed. An over-designed product will lead to high manufacturing cost and assembly time. Some special hardware is used in assembling the bread toaster. Moreover, there are also some parts are not functioned or unnecessary that can be eliminated. Hence, DFMA is expected to solve the problems in order to reduce the manufacturing cost and to ease the assembly process.

1.3 OBJECTIVES

The objectives of this project are listed as below:

i. To compare the design efficiency of the two selected bread toasters and new design.

ii. To improve the design of bread toaster using DFMA method.

1.4 SCOPE OF PROJECT

The scopes of this project are:

i. Only one type of bread toaster is selected for this report, which is pop up toaster.

ii. Two selected bread toasters will be dismantled, and each part of the bread toaster will be drawn using CAD software.

iii. Boothroyd-Dewhurst DFMA method is selected as a tool to analyze selected product and provide suggestions for redesign.

iv. Only one new design of bread toaster is proposed and designed using CAD Software based on DFMA guidelines due to time constraints.

v. Analysis and comparison of the design efficiency for both existing and redesign bread toasters will be done using DFMA analysis.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

In this chapter, details on Design for Manufacturing and Assembly (DFMA), Design for Assembly (DFA), and Design for Manufacturing (DFM) are described respectively. In addition, different evaluation methods of DFA like Hitachi Assembly Evaluation Method, Lucus-Hull Method, and Boothroyd-Dewhurst method are briefly discussed. Furthermore, several reviews on previous DFMA case studies are done in order to provide a better understanding.

2.1 PRODUCT DESIGN PROCESS

Product design process is a process of transforming the customers' requirement into a product that fulfill their needs. The key that drives the company toward success is to develop new products that satisfy the customer's requirement and released them into the market as fast as possible. A wide range of technologies is introduced by manufacturing industries to accelerate the manufacturing process as well as reduce the assembly time. There are two categories of product design process, which are traditional manufacturing process and concurrent engineering.

2.1.1Traditional Manufacturing Process

Traditionally, the behavior of the designers has been "we design it, you built it". (Boothroyd et al., 2002). This traditional manufacturing process is also known as "over-the-wall-approach" as shown in Figure 2.1. This term literally means that the designers pass the design to the manufacturing engineers after designing a product without any discussion or interaction between designers and manufacturing engineers. The designers just concentrated in the design of the drawing. They did not care about the manufacturing engineers who have to deal with a lot of manufacturing problems during the manufacturing process. The designers and manufacturing engineers work individually caused the final products have many disadvantages such as high cost, unguaranteed quality, long production time and so on.

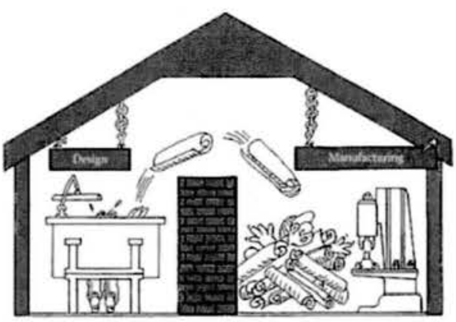

Figure 2.1: "Over the wall" design

Firstly, the conceptual sketches of each part are designed by the design engineers. Then, the detailed part drawing together with assembly view and exploded view are produced. The detailed drawings included the materials used, geometry, and detail dimensions with tolerances of the individual parts of a product. These drawings are then passed to the manufacturing engineers to fabricate a prototype. Normally, many manufacturing and assembly problems are discovered at this stage and feedback to the designers to request for design changes. In addition, some of the design changes are in a large number and require additional time to finish the design. This results the release of the final product is delayed. The total cost becomes more costly if the product design and development cycle changes happen later. Thus, the considerations about manufacture and assembly must take into account during early design stage as soon as possible. The flow chart of the traditional manufacturing process is illustrated in Figure 2.2.

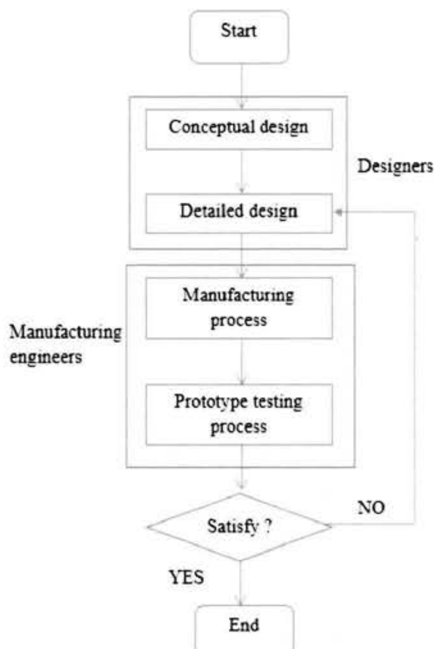

Figure 2.2: Flow chart of traditional manufacturing process

2.1.2 Concurrent Engineering

Concurrent Engineering (CE), also called as simultaneous engineering, is a technique whereby several teams work simultaneously to design and develop products. The teams may consist of members from different departments within an organization including mechanical design engineers, electrical engineers, software engineers, production engineers, sales and marketing, and management. Each member will study and evaluates the product design from their point of view and gives some feedbacks to