A COMPARATIVE STUDY ON THE DESIGN EFFICIENCY OF PRODUCTS USING DFMA METHODS

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This report is submitted to the Faculty of Mechanical Engineering in partial fulfillment of the requirements for the award of Bachelor of Mechanical Engineering (Design & Innovation)

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DECLARATION

"I hereby declare that the work in this report "A COMPARATIVE STUDY ON THE DESIGN EFFICIENCY OF PRODUCTS USING DFMA METHODS" is my own except for summaries and quotations which have been duly acknowledged."

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PSM II

by ngeow sook chin

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ABSTRAK

Projek ini bertujuan untuk mengaji secara perbandingan kecekapan reka bentuk produk dengan mengunakan kaedah **Design for Manufacturing and Assembly (DFMA)**. DFMA adalah teknik yang mantap dalam reka bentuk produk dari segi peningkatan kecekapan reka bentuk, pengurangan kos pembuatan, dan memendekkan masa pembangunan dengan menguraikan produk kepada komponennya. Kajian ini fokus kepada penilaian dan pembandingan kecekapan reka bentuk seterika daripada jenama berlainan yang boleh didapati dalam pasaran dengan menggunakan pendekatan DFMA dan memberi cadangan bagi penambahbaikan produk. Lukisan perinci produk dihasilkan dengan menggunakan CATIA V5R20 dan dianalisis dengan kaedah DFMA. Selepas analisis DFMA secara panduan, perbandingan telah dihasilkan antara seterika daripada kedua-dua jenama yang berbeza. Peratus reka bentuk didapati bahawa seterika berjenama National hanya 8.82% manakala seterika berjenama BRV sebanyak 10.34%. Seperti yang ditunjukkan dalam keputusan, seterika BRV adalah lebih unggul dari segi operasi pemasangannya dan juga kecekapan reka bentuknya berbanding dengan seterika National. Oleh itu, seterika BRV dicadangkan dengan modifikasi yang dilaksanakan untuk reka bentuk yang dipertingkatkan bagi tujuan DFMA. Konsep reka bentuk seterika baru ini terdiri daripada 10 bahagian yang berbeza dan sebanyak 16 komponen. Keputusan analisis DFMA menunjukkan peratusan kecekapan reka bentuk baru adalah 18.08%. Secara keseluruhannya, reka bentuk seterika baru mempunyai peratus kecekapan reka bentuk yang lebih tinggi dan masa operasi pemasangan yang lebih kurang berbanding dengan seterika BRV yang asal. Projek ini berjaya mempersembahkan peningkatan seterika dan juga mencapai objektif dan skop project ini.

ABSTRACT

This Project is conducted for the comparative study on the design efficiency of products by using **Design for Manufacturing and Assembly (DFMA)** method. DFMA is a well-established technique in product design in terms of improving design efficiency of the product; minimize production costs, and reducing development time by breaking down product into simplest components. This study focus on the evaluation and comparison of the design efficiency of two different brands of dry iron that available in the market, by using DFMA approach followed with the suggestion in improvement can be made on the product. The detail drawing of the existing design is done by using CATIA V5R20 software and analyzed the data with DFMA method. After manual DFMA analysis, the comparison is made between two different brands of dry iron. The percentage of design efficiency of dry iron (National) is 8.82% while dry iron (BRV) is 10.34%. As the result shows, the dry-iron (BRV) is much superior to the dry-iron (National) in term of its assembly operation and its design efficiency. Therefore, BRV dry iron is proposed with the implemented modifications for an enhanced design for the purpose of DFMA. The new conceptual design of dry iron consists of 10 different parts and total of 16 components. The DFMA analysis result shown the percentage of design efficiency of new conceptual design is 18.08%. From the overall result, the new conceptual dry iron has the higher percentage of design efficiency and lower assembly operation time compared to the existing dry iron (BRV). This project is success to show an improvement for a dry iron and also achieve the objective and scope of the project.

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E_{ma}	=	Assembly Efficiency
N_{min}	=	Theoretical minimum number of part
t_a	=	Basic assembly time for one part
t_{ma}	=	Estimated time to complete the assembly of the product
TM	=	Assembly time
TK	=	Operation cost
NM	=	Theoretical minimal part
DE	=	Design Efficiency

LIST OF ABBREVIATION

DFA	=	Design for assembly
DFM	=	Design for manufacturing
DFMA	=	Design for manufacturing and assembly

CHAPTER 1

INTRODUCTION

1.1 Background

Design for Manufacturing and Assembly (DFMA) is a well-established technique in product design to minimize production costs and development time by breaking down product into simplest components to give higher profit to the manufacturer. DFMA is combination methods of Design of Manufacturing (DFM) and Design of Assembly (DFA) (Boothroyd, 2002). DFA is focusing on the reduction of unwanted part count and easy assembly process with the same product function requirement. Meanwhile, DFM carry on the process by estimation cost, manufacturing process and material selection so as to choose effective shape forming processes (Boothroyd, 2002). So, DFMA is able to improve the design efficiency, minimize production cost and achieve customers' need (Mendoza, Ahuett, & Molina, 2003). Therefore, the cost function, and different design proposals may be evaluated in contrast to estimate the metrics of design efficiency.

1.2 Problem Statement

There are many products available in the market that served with the same function. There are different in term of design efficiency which is related to the number of component. Thus, research need to apply Boothroyd Dewhurst (DFMA) method to measure the design efficiency of the product that capable to give a suggestion to manufacturer. In order, manufacturer can improve the current design by eliminating and simplifying some of the part and trim down assembly time to get higher design efficiency of the product.

1.3 Objective

The main objective of this study is to evaluate and compare the design efficiency of products of different brands that served with same function by using DFMA approach and to suggest an improvement can be made on the product.

1.4 Scope of Study

The scope for this project is compared the design efficiency of products used Design for Manufacture and Assembly (DFMA) for:

1. To identify and select the product to studies.
2. To apply and analyze design efficiency on product using Boothroyd Dewhurst (DFMA) method.
3. To compare both design performances.
4. To suggest the improvement to each design based on DFMA analysis.

1.5 Project Outline

Chapter 1 includes the basic introduction of this project and emphasizes about the reasons and objectives of conducting this research.

Chapter 2 consists of the literature review which explains about the critical points of current knowledge and the application of Boothroyd Dewhurst DFMA in related to the project.

Chapter 3, the methodology to establish this project and procedure to analyze the comparative products design efficiency is explained. This includes part evaluation obtained in the CATIA V5R20 drawing and analyzes the data with manual DFMA method.

Chapter 4 conducts the manual Boothroyd Dewhurst DFMA analysis for the existing design and carry out a modification suggestion in new conceptual design with the DFMA analysis.

Chapter 5 discuss the comparison between two difference brands of existing products based on the manual DFMA analysis result. After that, the comparative of design efficiency for the existing design and new conceptual design from manual DFMA analysis result is discuss in this chapter.

Chapter 6 denotes conclusions and recommendations which summarize the finding of this research and give beneficial suggestion for future investigation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses about the Design for Manufacturing and Assembly (DFMA), Design for Assembly (DFA) method, Design for Manufacturing (DFM) method and overview on previous case studies and perspective approach which is related to the project.

2.2 Design for Manufacturing and Assembly (DFMA)

DFMA is an advance method which plays as important role in early stage of products designed and manufacturing system. This method that significant effect product cost, product quality, productivity and time to market (Boothroyd, 2002). This idea can speed up the development process through the past experience of previously mistakes. It is also accomplish new technologies and philosophies to ensure that activities process

quickly and give more precise results that can achieved desired target (Pedro & Kovalchuk, 2006).

DFMA is combination methods of Design for Manufacturing (DFM) and Design for Assembly (DFA) (Boothroyd, 2002). In **Table 2.1** provides all the parameter of DFM and DFA analysis. DFM and DFA plays a vital role in DFMA methods for improved the design efficiency of the product and determined how to simplify the current or future product design. In **Figure 2.1** showing that the application of DFMA shortens the time to bring to market compared with traditional design process. Traditional design process is a process which to divide in every single phase of the development process. The traditional development process included engineering design, manufacturing, testing, marketing and production. The next phase can only route when the previous phase is done. If the early phase of development process get stuck in then the following development process phase will not able to process and stuck in also. This is orderly step-by-step process very slow and lead product lost sales in this competitive market place.

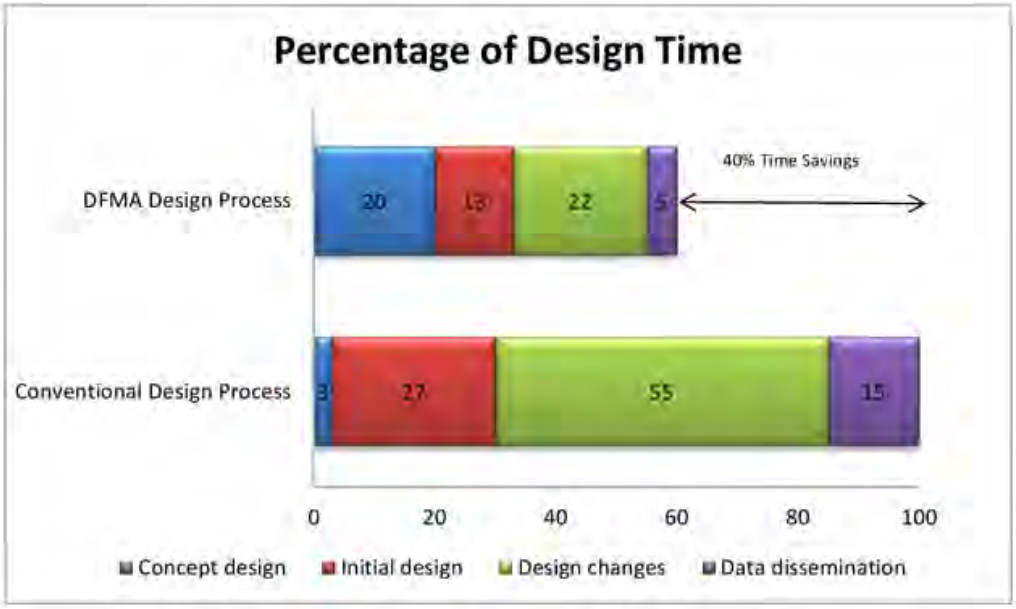

Figure 2.1 : Time to deliver comparison between DFMA and traditional design process (Boothroyd, 2002)

Table 2.1 : Analysis of the influence of the different between DFM and DFA parameters (Harik & Sahmrani, 2010)

DFM/ DFA Parameters	**Manufacturing**	**Assembly**
Billet Dimensions	Machine Selection Availability of standard Billet	Manual or Automated
Work Material Properties	Ease of manufacturing	Physical Properties – Density, volumetric cost
Features	Machining Time based on type	Tangling Jam Slippery
Thin Features	Particular Manufacturing	Special Handling
Tool Identification	Availability in workshop	-
Manufacturing Fixtures		
Machine Accessibility		
Operations Sequence	Grouping similar operations Eliminating redundancy	-
Part Handling	-	Sharpness Slippery Flexibility
Assembly Fixtures	-	Availability Selection of the most suitable
Standard fastening parts	-	Availability Cost
Chamfer to guide insertion	-	Availability
Number of Parts	-	Assembly time
Tolerance and clearance	-	Insertion Time and Effort