OPTIMIZATION DESIGN OF SLICING MACHINE USING DESIGN FOR MANUFACTURING AND ASSEMBLY (DFMA) METHOD

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Design) (Hons.)

by

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I hereby, declared this report entitled "Optimization Design of Slicing Machine using Design for Manufacturing and Assembly (DFMA) method" is the results of my own research except as cited in references.

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Date :10th June 2013

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Design) (Hons.). The member of the supervisory is as follow:

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ABSTRAK

Projek ini adalah untuk menunjukkan penggunaan kaedah Rekabentuk Pembuatan dan Pemasangan (DFMA) dalam proses pembangunan produk. Di dalam projek ini, mesin pemotong di pilih sebagai produk di dalam proses Rekabentuk Pembuatan dan Pemasangan (DFMA). Objektif projek ini adalah untuk mengurangkan bahagian-bahagian komponen di dalam mesin pemotong di samping untuk menganalis bahan dan proses yang sesuai digunakan dalam penghasilan mesin pemotong. Di samping itu juga, kaedah Rekabentuk Pembuatan dan Pemasangan (DFMA) di pilih kerana kaedah ini dapat mengira kos tenaga kerja yang diperlukan dalam proses pembuatan. Bagi memudahkan proses analisis, perisian Boothroyd-Dewhurst DFMA digunakan. Perisian ini di pilih kerana ia terbukti berkesan untuk mengurangkan komponen-komponen dalam sesuatu produk dan mudah digunakan oleh pereka. Hasil kajian ini telah menunjukkan DFA indeks reka bentuk baru mesin pemotong meningkat 26% daripada reka bentuk asal dan kos reka bentuk baru adalah 45.27% lebih rendah dari RM9500.07 kepada RM5199.07. Kesimpulannya, DFMA digunakan sebagai asas untuk kajian kejuruteraan serentak untuk memberi panduan kepada perekabentuk dalam merekabentuk produk. Selain itu, Rekabentuk untuk Pembuatan (DFM) telah digunakan untuk memilih proses yang paling sesuai dan bahan-bahan dengan bimbingan sifat bentuk dalam carta keserasian. Tambahan pula, peringkat Rekabentuk untuk Pemasangan (DFA) adalah kaedah penting yang boleh digunakan untuk meningkatkan reka bentuk produk. Dalam usaha untuk meningkatkan projek ini, beberapa cadangan telah dirancang iaitu di harap kajian mengenai potensi bahagian geometri antaramuka atau data komponen yang dihubungkan dengan perisian dapat dilakukan. Projek ini diharap dapat diteruskan ke peringkat fabrikasi. Tambahan pula, pemilihan bahan mestilah memenuhi beberapa spesifikasi seperti dapat menahan daya tujah, suhu dan tekanan,.

ABSTRACT

This project is to demonstrate the use of Design Manufacture and Assembly (DFMA) in product development process. In this project, slicing machine is chosen as the product to use in the process of DFMA. The objective of this project is to reduce the number of component of the cutter as well as to analyse the materials and processes involved in the production of slicing machine. In addition, the method of DFMA is chosen due its ability to calculate the cost of labour required in the manufacturing process. To ease up the analysis, Boothroyd-Dewhurst DFMA software was used. This software is chosen due to its effectiveness in reducing the components in a product and which is convenient to be utilized by designers. The results of this study are the new design of slicing machine in which 26% improvement from original design in DFA index and the cost of the new design is 45.27% lower than the original design from RM9500.07 to RM5199.07. As for the conclusion, , DFMA is used as the basis for concurrent engineering studies to provide guidance to the designs in designing the product. Besides that, Design for Manufacturing (DFM) was applied to choose the most suitable process and material with the guidance of the shape attribute in the compatibility chart. Plus, Design for Assembly (DFA) stage is a vital tool that can be used to improve the product design. In order to improve the project, several recommendations has been planned which is a research on the potential of geometry interface part or components data to be linked to the software can be conducted. This project are recommended to be preceded into the fabrication stage. Plus, the material chosen must consists several specifications such as it can resist force, temperature and pressure.

DEDICATION

This report is dedicated to my parents, brothers and sisters for their endless love, support and encouragement. I also dedicate this work to my supervisor and friends who have supported me throughout the process. I will always appreciate all they have done. Thank you.

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First of all, I would like to express my thankfulness to Allah S.W.T the Almighty because I manage to finish this Final Year Project on time. With full of His merciful, now I am writing this report of this project.

I also like to state my gratitude to my supervisor, Engr. Dr Hambali B. Ariff @ Arep for his assistance and guidance in producing this report and giving me his constructive comments, guidance, patience and encouragement until the completion of this report. Besides that, I would like to express my thankfulness to my parents and friends for their continuous supports and advices in complete the report.

I hope that this project report will fulfill the conditions as requested in Final Year Project in UTeM.

Thank You.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

DFMA	=	Design for Manufacture and Assembly
DFA	=	Design for Assembly
DFM	=	Design for Manufacture
BD-DFA	=	Boothroyd Dewhurst Design for Assembly
AEM	=	Assembly Evaluation Method
OD	=	Optimization Design
KTP	=	Knowledge Transfer Program
BDI	=	Boothroyd Dewhurst Inc.
CE	=	Concurrent Engineering
ASF	=	Assembly Sequence Flowchart
MOP	=	Measures of Performance
UTeM	=	Universiti Teknikal Malaysia Melaka
PSM 1	=	Projek Sarjana Muda 1
PSM 2	=	Projek Sarjana Muda 2
BDI	=	Boothroyd Dewhurst Inc
IPM	=	Interior Point Method
FEA	=	Finite Element Analysis

CHAPTER 1
INTRODUCTION

This chapter discusses the background of the project, problem statement, objective and scope of the project.

1.1 Background of Project

This project is actually related to the industry based. In other words, this project solve a problem that occurs in a factory. TR Technology Sdn Bhd is the factory that was selected for collaboration with this project. TR Technology Sdn. Bhd. is located at Seksyen 16, Shah Alam, Selangor. TR Technology Sdn Bhd is a factory which runs a business based on the process of stamping and cutting. Among the activities run in this factory is the process of cutting rubber sheets. In accordance with the process, the problem that arises is the cutting method of the sheets, which they are still using old-fashioned clasp knives. By using this outdated method, it has had wasted the time and cost, the workers' energy, productivity and the output of the product. To solve of the factory problems, DFMA concept is chosen as a main concept for this project.

The DFMA concept is chosen due to the following factors :-

a) It can increase the quality of new produces during the developmental period, including design, technology, manufacturing and service.
b) It can decrease the cost, including the cost of design, technology, manufacturing, delivery, technical support and discarding.

c) Shorten the development cycle time, including the time of design, manufacturing preparing, and repeatedly calculation. (Xie, 2002).

1.2 Problem Statement

At the TR Technology Sdn. Bhd, the rubber sheets cutting process is still done by using the conventional method which is using clasp knives (refer to Figure 1.1).

Figure 1.1: Conventional Cutting Process

Therefore, TR Technology Sdn. Bhd. has asked UTeM committee to assist in developing a slicing machine that can reduce wastage material, labor working duration and increase the productivity. The problem arising here is to design a slicing machine that is not yet available in the market. Besides that, the new design of slicing machine has to meet the requirements of the clients, TR Technology Sdn. Bhd. There are also other problems that occurred at this factory. There are :-

a) Ineffective cost-down activities and strategies.
b) Requirement for better improvement in productivity to be competitive in market need further concerted effort.
c) Market penetrations are not achieved as per desired level.

1.3 Objectives

The main objective of this project is to improve the design of the slicing machine. Specific objective as follows :-

a) To reduce the number of parts through DFMA method.
b) To identify the most appropriate material and process for the product.
c) To improve the original design by using DFMA method.

1.4 Scope of Project

The scopes of this project are set at an early stage of the project to ensure that the objective of the project can be achieved. The scopes for this project are :-

a) To design a 3D modeling using Solidwork software.
b) To use a Boothroyd-Dewhurst software for product evaluation.
c) To analyze the methods of manufacturing and assembly of the existing design.

CHAPTER 2
LITERATURE REVIEW

This chapter covers on the explanation about Design for Manufacturing and Assembly (DFMA) and Optimizing Design (OD). Besides that, this chapter is also highlight the relationship between DFMA and OD.

2.1 Optimization Design (OD)

According to Monge (2001), such design optimization is derived from a formula and solved to gain insight into the converter design tradeoffs and particularities. Until then, a discrete optimization approach is comprised from a genetic algorithm to develop a completely automated user-friendly software design tool, capable of providing globally optimum designs for systems with different sets of specification, in a period of time.

Engineering design optimization is an emerging technology, with its application both shortens design-cycle time and finds new designs that are not only feasible, but optimal, based on the design criteria. In the early days, optimization design had to begin by deriving a formula for design requirements. After that, an initial design is synthesized which must be tested against the requirements, hence creating a prototype and performing experiments. A build-up of a computer model may follow, using one of the many engineering analysis codes, and then the design is validated experimentally since these codes are not accurate. Such a design is found to have defaults in some parts, it is then altered and the process repeats again. The process is executed on and on until the requirements are met or changes are made to fit

performance. This concludes that the process is time consuming and seldom produces the perfect design, just a feasible one (Johnson, 2004).

Optimization methods are formulated to bring out the best values of system design and operating policy variables – values that will lead to the optimum level of performance. When combined with more detailed and accurate simulation methods in short of building an actual model, can be the primary way of estimating the likely impacts of system designs and operating policies (Loucks, 2005).

Optimization can be a subject of dealing the problems of minimizing or maximizing a certain function in a finite dimensional Euclidean space over a subset of that space which is usually determined by functional inequalities (Anjos and Zhang, 2006).

2.2 The Usage of Optimization Design in Improving Design

With engineering design optimization, it reduces both the time for the design iteration loop and finds the optimum design based on specifications. Unlike the traditional process, the iteration loop is computerized. An optimization problem is posed for which the design variables, the design objectives and all constrai8nts are specified. An appropriate engineering analysis code is combined with an optimization algorithm, which serves as the design modifier (Johnson, 2004).

The history of the application of optimization in engineering goes a long way. In common application areas of engineering such as transportation, production planning, design and data fitting, power plants and so on, uses widely the two special classes of optimization problems, linear least squares and linear optimization problems. The introduction of highly efficient Interior Point Method (IPM) based algorithms and software for convex optimization since the 90s has motivated people to apply convex optimization models in numerous areas of engineering, such as communications, automatic control systems, signal processing, networks, product and shape design, truss topology design, electronic circuit design, data analysis and modeling, statistics and finance, engineering (Anjos and Zhang, 2006).

2.3 Design for Manufacturing and Assembly (DFMA)

2.3.1 History of DFMA

Before the Second World War, Ford and Chrysler use the DFM philosophy in their design and manufacturing process of the weapons, tanks and other military products. It was in the beginning of the 1970's, when Dr. Geoffrey Boothroyd and Dr. Peter Dewhurst, who founded the Boothroyd Dewhurst Inc. (BDI) in1982, they were the pioneers in this new technology. The "DFMA" in actual became their company trademark. They created and developed the DFMA concept which is used in developing the products of their company, the DFMA software system. Currently these programs are used to help the design in almost all the industrial fields including circuit boards, with manual assembly, with robotic assembly, and with machining. They also do a lot of work examining the economic justification of each design revision (Xie, 2005).

2.3.2 What is DFMA?

The term "DFMA" comes with the combination of DFA (Design for Assembly) and DFM (Design of Manufacturing) as shown on Figure 2.1. The basic concept of it is that the design engineers apply the DFMA paradigm or software to analyze the manufacturing and assembly problems at the early design stage. In other words, all the possible factors that will affect the outcome will occur just as in the design stage. Less precious time will be wasted on the early design stage as during repeatedly redesign stage, and costs are reduced in the meantime (Xie, 2005).