PRODUCT DESIGN IMPROVEMENT THROUGH DESIGN FOR MANUFACTURE AND ASSEMBLY (DFMA) AND THEORY OF INVENTIVE PROBLEM SOLVING (TRIZ)

AFZAN BINTI ROZALI

A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Mechanical – Advanced ManufacturingTechnology)

Faculty of Mechanical Engineering
Universiti Teknologi Malaysia

MAY 2010

To my beloved parents. Thank for all your support.

ACKNOWLEDGEMENT

Firstly, I would like to give all the praise to the Almighty Allah for the goodness that He had given to us and to all of the human beings. For Him, I have been able to complete my project successfully, *Alhamdulillah*.

And, I would like to express my deepest gratitude and appreciation to our beloved project supervisor, Dr Ariffin bin Haji Abdul Razak, for his valuable guidance throughout the completion of this project. Needless to say, it was his guidance and support that made my project time period much more beneficial and insightful into the engineering working environment.

I would like to thanks, Pn Sharifah Zainaf bte Wan Abu Seman, for the valuable discussion and supports. Your help is undeniable grateful.

Special credit to all my classmates of Kolej Kemahiran Tinggi MARA Balik Pulau, for spending their preicious time advising and contributing ideas during product improvement is being conducted.

Finally, I would like to thank my sisters and all those unmentioned that have helped me in various ways, direct or indirectly. May Allah bless you all.

ABSTRACT

The goal of this project is to improve product design of consumer product by integrating Boothroyd Dewhurst Design for Manufacture and Assembly (DFMA) methodology with a Russian Theory of Inventive Problem Solving (TRIZ). The outcome of previous research has shown integrating several design tools has improved the reliability and reduce cost of the product.

A consumer product was selected as a case study to evaluate the integration of both design tools. The Boothroyd Dewhurst Design for Manufacture and Assembly Methodology (DFMA) is used as a quantitative improvement tools. The powerful tool can reduce parts number of a product and is expressed in percentage. While, the Russian Theory of Inventive Problem Solving (TRIZ) is used to improve the design qualitatively.

The results show that the integration of these tools can be a very powerful design tool for product design engineers in reducing cost by eliminating unnecessary parts while improving the ease of user handling and reliability of the consumer product.

ABSTRAK

Tujuan projek ini adalah untuk memperbaiki reka cipta produk bagi barangan pengguna dengan menggabungkan metodologi Boothroyd Dewhurst Design for Manufacture and Assembly (DFMA) dengan Russian Theory of Inventive Problem Solving (TRIZ). Hasil kajian terdahulu telah menunjukkan penggabungan beberapa alat reka cipta telah memperbaiki kebolehpercayaan dan menurunkan kos barangan.

Satu barangan pengguna telah dipilh untuk menilai penggabungan kedua-dua alat reka cipta tersebut. Metodologi Boothroyd Dewhurst Design for Manufacture and Assembly Methodology (DFMA) digunakan sebagai alat penambahbaikan secara kuantitatif. Alatan yang berpengaruh ini mampu mengurangkan jumlah bahagian sesuatu barangan dan dinyatakan dalam peratusan. Manakala, Russian Theory of Inventive Problem Solving (TRIZ) digunakan untuk penambahbaikan dari segi kualiti.

Hasil kajian menunjukkan bahawa penggabungan kedua-dua alat rekacipta boleh menjadi sangat berkesan untuk jurutera pereka bentuk produk dalam menurunkan kos melalui pengurangan jumlah bahagian sambil memperbaiki kemudahan pengendalian barangan pengguna.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DFMA	-	Design for Manufacture and Assembly
TRIZ	-	Theory Inventive Problem Solving
D.E	-	Design efficiency
TM	-	Total manual assembly time
CM	-	Total cost of manual assembly
NM	-	Theoretical minimum number of parts
No.	-	Number

LIST OF SYMBOLS

α	-	Alpha rotational symmetry
β	-	Beta rotational symmetry

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction to Problem

The significant demands made on engineers to reduce assembly time, improve performance and reliability at a reduced cost requires the ability to improve the design of the existing product. It necessitates the improvement of the existing design to reduce the number of parts and ease of user handling. In addition, the improved design needs to be performing the same function or more with ease of assembly, reduce in cost and ease of handling.

1.2 Background of Research

Engineering product design and improvement are crucial tools to provide reliable performance with a minimum numbers of parts and minimum production cost. In engineering production area, the constraints of the existing product are nearly always associated with the number of parts and assembly time. In the design of consumer product, increases in number of parts are closely related to cost of the

product. In order to compete with other, the manufacturer needs to manipulate the selling price of their product and offer more reliable and better functioning product. In suit to the reduced in selling price, the manufacturer must reduce the cost. In addition, survival of a consumer product relies on the ease of product handling and more practical.

The evaluation on a selected consumer product will be used to support this premise and examples the use of techniques to aid the definition of the design problem and control the premature criticism of the design concept.

1.3 Problem Statement

It is crucial to improve the design of products, reducing costs, improving quality and gaining competitive advantage. As the basis of competition has now shifted significantly towards the quick delivery of more and more innovative products manufacturers are looking for ways to enhance their technical innovation and creative problem solving techniques without losing control over product cost and quality.

Most product manufacture problems faced are designing parts that are hard to manufacture. Manufacture difficulties will increase the manufacturing and fabrication cost. An increase in cost will directly raise the selling price.

Another common product manufacture problems faced are wrong parts material chosen. Unsuitable material will affect the performance of the product. While using superior materials than the part should be will increase the material cost.

Parts face difficulties during assembly are another root cause of product manufacture problems. Difficulties during assembly will increase the assembly time and so the cost. Many designs require more than necessary number of parts to perform it functions. Malfunction parts will increase assembly time should be eliminated.

The reliability of product is the supplementary to the product shelf lifetime. So the improvement in design should in consideration of the product reliability and serve the consumer more practical and functioning product but still a lower price.

1.4 Objective of Project

The objective of this project is to improve product design through Design for Manufacture and Assembly (DFMA) methodology and Theory of Inventive Problem Solving (TRIZ) approach.

1.5 Scopes of Project

Scopes of this project are limited to:

i. Application of Boothroyd Dewhurst Design for Manufacture and Assembly (DFMA) methodology in product assembly time as quantitative improvement on product design problem using manual assembly

ii. Integrate the quantitative improvement by Boothroyd Dewhurst DFMA to qualitative improvement by Theory of Inventive Problem Solving (TRIZ)

iii. Integration for improvement on mechanical part of a selected consumer product as case study assuming using manual assembly

1.6 Significant of Research

The research finding shall be indispensible of improving the existing product design in terms of cost, minimize parts numbers and ease of handling. The capability of Boothroyd Dewhurst DFMA methodology should help product design engineer to increase product design efficiency. Additional Theory Inventive Problem Solving (TRIZ) strategies should usefully deploy to qualitatively enhance Boothroyd Dewhurst DFMA capability.

With the application of DFMA and TRIZ methodology this research will benefits design engineering as a guide on how to apply this two powerful design tools for a more reliable and better functional products at a lower cost. This will indirectly benefit the consumer and the environments.

1.7 Methodology of Study

The methodology of study begins with literature review on both design tools DFMA and TRIZ. The scrutinized on the combination of these two tools on previous researches are also conducted to see the effectiveness of design improvement.

A consumer product is selected after clear view on the application of latter tools. The selected product is firstly is analysed using DFMA methodology. Then, by application of DFMA, a better design is proposed.

The improved design through DFMA is then again improved by integrating with TRIZ. The Design Efficiency of DFMA methodology is used to evaluate the latest improved design.

The Design Efficiency is used as quantitative tool and stressed upon discussion and conclusion of the finding.

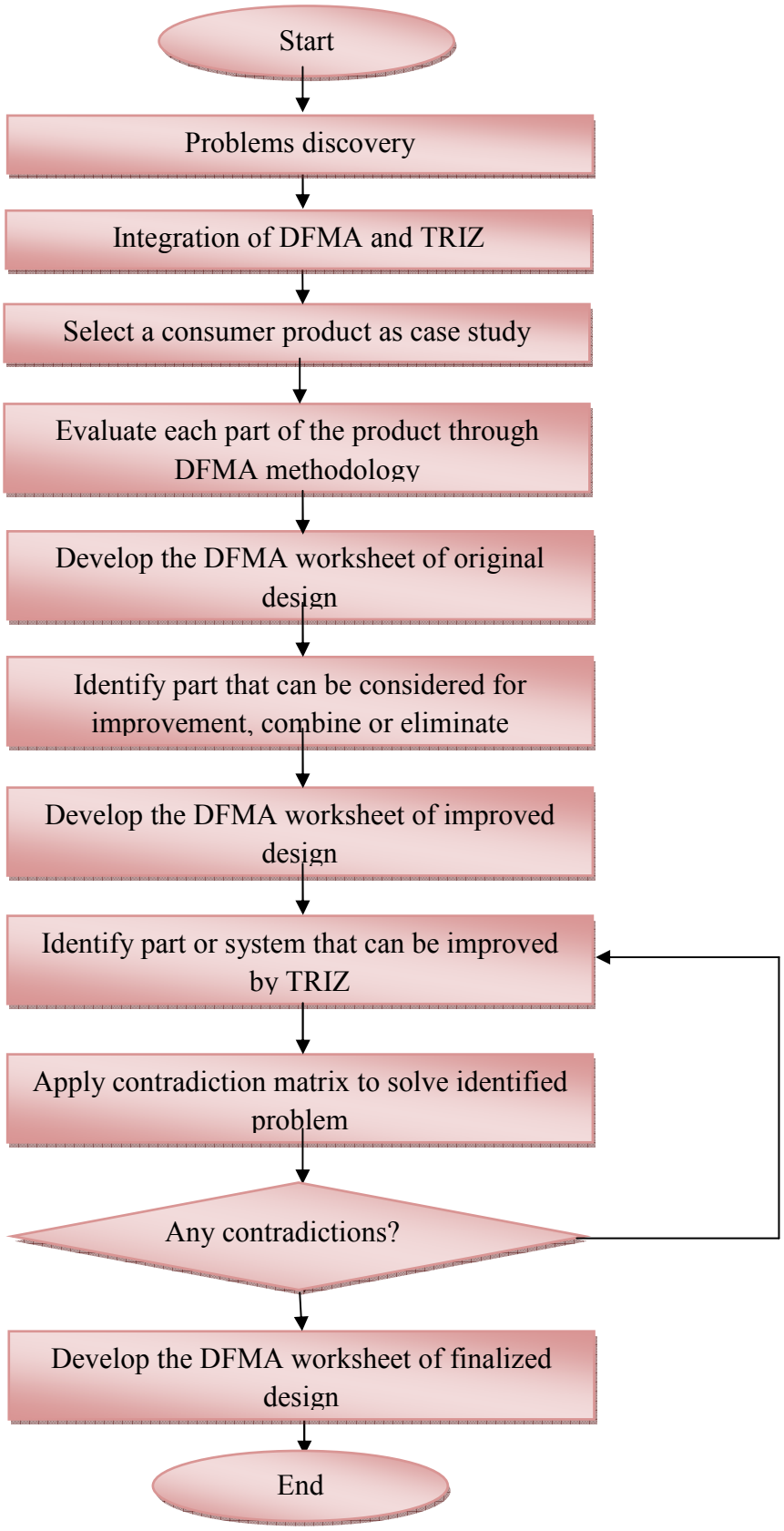

Figure 1.1: Methodology of Study

1.8 Summary

DFMA and TRIZ could be considered as combined design tool that can solve many product design problems during early design stage which capable to deliver simple design with same or better functioning. The outcomes are seen as one of the most reliable after sales.