PRODUCT DEVELOPMENT THROUGH DESIGN FOR ASSEMBLY (DFA) AND THEORY OF INVENTIVE PROBLEM SOLVING (TRIZ) METHODOLOGIES OF ELECTRIC BARBEQUE GRILL

ILYAS TUFAIL BIN BASHARUDIN

UNIVERSITI TEKNOLOGI MALAYSIA

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Faculty of Mechanical Engineering
Universiti Teknologi Malaysia

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For my dad, mum, bro and sis…

Thank you for your love and support

Alhamdulillah, I managed to complete this project in time and without any hindrances.

For my beloved wife Norlida..

Your help and kindness are so precious and irreplaceable with any valuable thing.

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ABSTRACT

Design for Assembly (DFA) is an approach to simplify the product through reducing number of parts by eliminating or merging the particular parts. Meanwhile, Theory of Inventive Problem Solving (TRIZ) is a systematic tool that enhances the decision making through systematic procedure either than trial-and-error method. This project report describes on the integration of DFA and TRIZ methodologies for the design improvement. A household appliances consumer product was selected as a product case study. DFA analysis for the original design of product case study was conducted. The results than are compared to the new design proposed by the DFA methodology. Through TRIZ approach, trimming methods are used in order to develop the specific solution problem solving arise during the process of design improvement. The result than was analyzed using DFA analysis. TRIZ will booster up the design efficiency. Integration of DFA and TRIZ methodologies are able to improve the design efficiency by simplifying the parts.

ABSTRAK

Reka bentuk untuk Pemasangan (DFA) merupakan satu kaedah untuk meringkaskan produk melalui pengurangan bilangan komponen produk dengan menghapuskan atau menggabungkan komponen produk. Manakala Teori Mencipta Penyelesaian Masalah (TRIZ) merupakan alat yang sistematik dalam membuat keputusan yang lebih mantap berbanding kaedah cuba jaya. Laporan projek ini menerangkan tentang integrasi kaedah DFA dan TRIZ bagi peningkatan reka bentuk. Satu barangan kelengkapan rumah telah dipilih sebagai kajian kes produk. Analisis DFA terhadap reka bentuk produk asal dijalankan. Kemudiannya, hasil dapatan dibandingkan dengan reka bentuk baru yang dicadangkan melalui kaedah DFA. Melalui pendekatan TRIZ, pemotongan *(trimming)* digunakan untuk membangunkan penyelesaian spesifik bagi percanggahan permasalahan yang timbul semasa proses meningkatkan reka bentuk. Keputusan ini kemudiannya dianalisa menggunakan analisis DFA. TRIZ akan menggalakkan kecekapan reka bentuk. Integrasi di antara kaedah DFA dan TRIZ mampu meningkatkan kecekapan reka bentuk dengan meringkaskan komponen.

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LIST OF ABBREVIATIONS

ABBREVIATIONS	TITLE
DFA	Design for Assembly
DFMA	Design for Manufacturing and Assembly
TRIZ	Theory of Inventive Problem Solving
DE	Design Efficiency
TM	Total Manual Assembly Time
CM	Total Cost of Manual Assembly Time
NM	Theoretical Minimum Number of Parts
BBQ	Barbecue

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction to the Problem Statement

Now a day, product design simplification is important due to the rapid changing of customer demands, more competition and so on. Yet, manufacture is being forced to produce product that meet the customer requirement with high expectation such as product functionality but in lower cost. So, designer needs to design product with maximize value in order to fulfil that requirement. In recent decades the search for significant cost-saving effects that characterize major process innovations has driven manufacturers towards simplifying their products. In fact, when compared to process improvements in the production of complex assembled products, product innovations have a more profound impact on productivity, costs and quality.

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 carry out the same function or more with simplicity of assembly, reduce in cost and ease of handling.

Basically, there are two sort of problems for any given product design or process which are those where the solution is generally known and those where it is not. If the solution is generally known, it can be found in books, journals, or technical paper. Problems where the solutions are not generally known are called inventive problems and often offer contradiction requirements. Mostly, many people will choose a compromised solution, where not all of the requirements are met and those that are met, are not optimized in order to resolve contradictory requirements or conflict. In this case, there are several ways to solve the problem. The use of integrated several VE tools will help to resolve conflict and generate new solutions from outside the experience.

1.2 Objectives of Projects

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

1.3 Scope of Projects

The study will focus on the:

i. Application of DFA methodology to identify detailed design problems and generate remedial design solutions

ii. Application of TRIZ method to improve the value added product development .

iii. Consumer product as case study is Electric Barbeque Grill

1.4 Methodology of Projects

This study will be carried out into two semesters which in Semester 1 is Master Project 1 (MP 1) and in Semester 2 is Master Project 2 (MP 2). The activities will be structured accordingly as shown in Figure 1.1. For the beginning, the literature review on both DFA and TRIZ are studied by reviewing journals, books, articles and others researchers findings. As well as the main idea was gathered, product of the case study will determine which focusing on consumer product to be investigated. DFA evaluation of the original design of the product case study will be analysed. From the result obtained, new design improvements were suggested.

The new design improvements will continue studying in Semester 2 but this time by guiding method and tools in TRIZ. The idea of integration of DFA and TRIZ were implemented in the new design. Furthermore, the evaluation of DFA once again conducted for the new design. Finally, the percentages of Design Efficiency, Estimated Assembly time and numbers of parts reduction will be compared in discussion and conclusion. The general flow of the projects represents by the Figure 1.1.

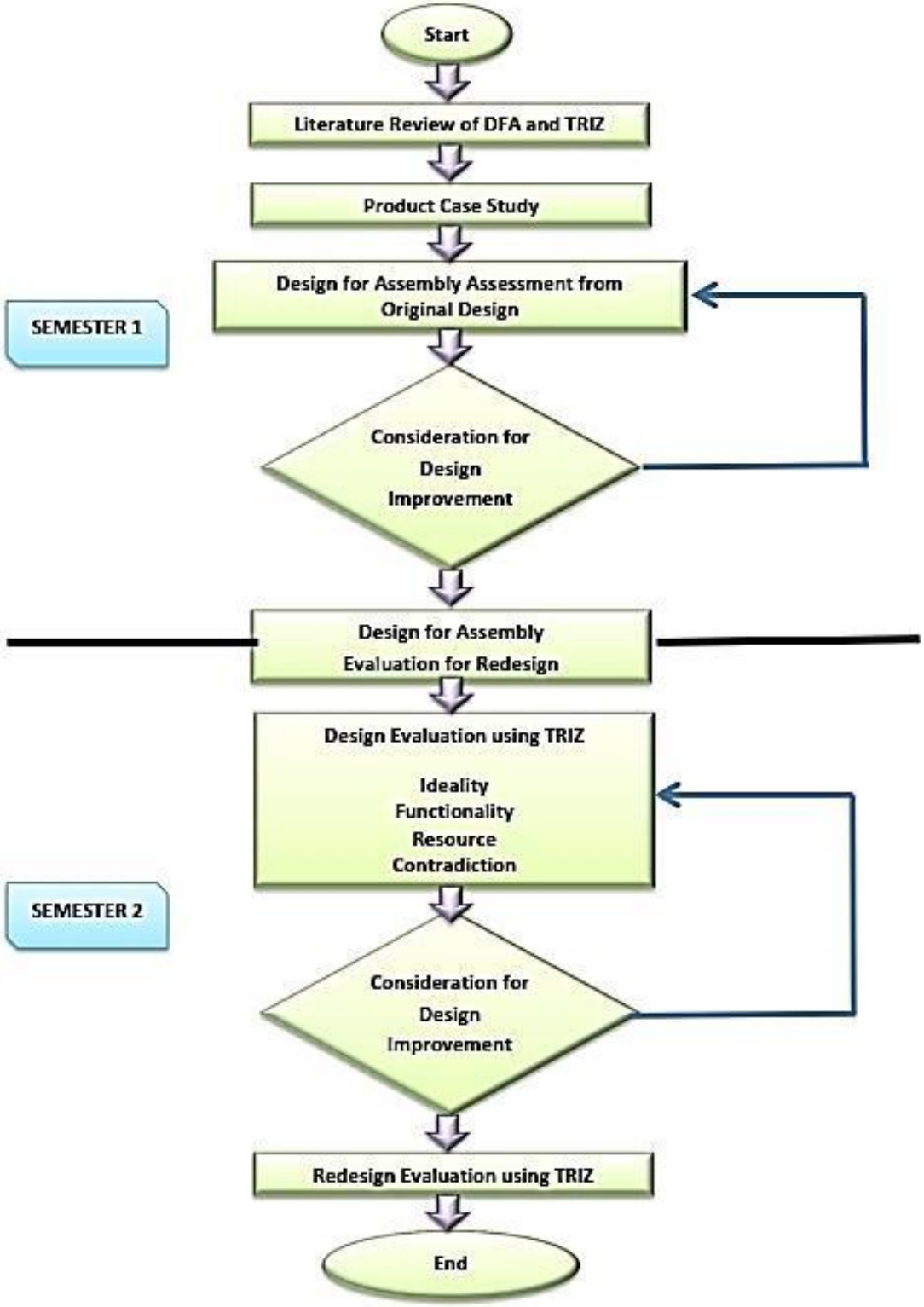

Figure 1.1: Flowchart Represents the Scope of Work

Table 1.1 Gantt Chart for Research Schedule Planning for Master Project I

ACTIVITIES	Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Date	9-13/9	10-20/9	23-27/9	30/9-4/10	7/11/10	14-18/4	21-25/10	28/10-1/1	4/8/11	11-15/11	18-22/11	25-29/11	2-6/12	9-13/12	16-20/12	23-27/12	30/12-3/1	6-10/1	13-17/1
Master Project 1 Briefing & Title Selection	Plan																			
	Actual																			
Literature Review	Plan																			
	Actual																			
Product Case Study	Plan																			
	Actual																			
Design for Assembly (DFMA) Evaluation for Original Design	Plan																			
	Actual																			
Consideration for Design Improvement	Plan																			
	Actual																			
Design for Assembly (DFMA) Evaluation for Redesign Design	Plan																			
	Actual																			
Draft / Report Writing	Plan																			
	Actual																			
Seminar - Master Project I Presentation	Plan																			
	Actual																			

Table 1.2 Gantt Chart for Research Schedule Planning for Master Project II

ACTIVITIES	Week	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17
	Date	10-14/2	17-21/2	24-28/2	3-7/3	10-14/3	17-21/3	24-28/3	1-5/4	7-11/4	14-18/4	1-5/5	6-10/5	12-16/5	19-23/5	26-30/5	2-6/6
Design Evaluation using TRIZ	Plan																
	Actual																
Design Improvement using TRIZ	Plan																
	Actual																
Comparison of DFMA & TRIZ Results	Plan																
	Actual																
Report Writing	Plan																
	Actual																
Seminar - Master Project II Presentation & Report Submission	Plan																
	Actual																

1.5 Significant of Study

The research finding shall be indispensable of improving the existing product design in terms of cost, minimize parts numbers and ease of handling. The capability of Boothroyd Dewhurst DFA 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 DFA capability.

With the application of DFA 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.

1.6 Structure of Report

This reports begins with literature review on both design tools DFA and TRIZ. Previous research and reports form industries reveal that the applications of DFA have shown improvement in part design and assembly and there are several TRIZ tools that can be implemented to solve any problem that arise.

The combination of DFA and TRIZ offer many advantages to the product innovation and development process. In particular, as designs are evolve towards minimum part count, during DFA, finding the best solution often requires a shift to a new design, this is where TRIZ can be effectively deployed. 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 DFA methodology. Then, by application of DFA, a better design is proposed. Components with minor function but roughly bring high impact during assembly will be focused to be improved in future. Before DFA analysis being conducted, each part was identified and given part identification number.

From DFA analysis result, the product design efficiency has been quantified and will act as a guidelines or standard for further improvement. The DFA results for new design show significant impact to the design efficiency of electric barbecue grill. DFA is a helpful tool in order to improve the design efficiency which is directly give positive impact to the assembly time and costs.

The improved design through DFA is then again improved by integrating with TRIZ. The Design Efficiency of DFA 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.

1.7 Summary

DFA 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.

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