INTEGRATION OF DESIGN FOR MANUFACTURING AND ASSEMBLY(DfMA) AND THEORY OF INVENTIVE PROBLEM SOLVING (TRIZ) FOR DESIGN IMPROVEMENT

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Special dedications to my respected parents Wan Osman Tku Mahjar Al-Edrus and Sharifah Hamimah Ismail Al-Sagaf. Highly appreciations to my beloved husband Azmi Bin Md Isa and my daughter Nur Atiqah Maisarah Binti Azmi.

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ABSTRACT

The quality of the product mostly depends on element such as product design, material used, function, assembly time and manufacturing cost. So a systematic method procedure needs to achieve the target need. Methods to be developed are with the help of TRIZ (the Russian abbreviation of the theory of inventive problem solving) and DFMA (design for manufacturing assembly approach). These methods focus on innovation within the whole function and mechanism structure of the base product. The approach methods been used based on criteria in each method and all the criteria will be analysed during product design stage. During the stage of design, a significant amount of information is gathered and analyzed to support the decision making process that leads to the synthesis of products. This approach first reveals the contradictions that block the target quality from being reached, based on the engineering solutions that the current base product employs and the phenomena that take place while the base product is performing its function. This will make product more competitive and effective with good quality and at the same time reduce the conflict faces.

ABSTRAK

Kualiti sesuatu produk amat bergantung kepada beberapa elemen seperti reka bentuk, jenis bahan yang digunakan. fungsi, masa pemasangan dan juga kos pembuatan. Maka satu kaedah sistematik amat diperlukan bagi mencapai target yang dikehendaki. Kaedah yang dibangunkan adalah integrasi dari 2 kaedah iaitu kaedah Boothroyd-Dewhurst - Design for Manufacturing And Assembly (DFMA) dan juga kaedah Theory Inventive Of Problem Solving (TRIZ). Integrasi kaedah ini lebih kepada inovasi sesuatu produk di mana analisis bagi setiap elemen di atas ditekankan. Teknik yang digunakan dalam menyatukan kaedah ini berdasarkan kepada kriteria-kriteria yang terdapat dalam setiap kaedah tersebut. Setiap kriteria tersebut akan diperinci dengan teliti semasa proses mereka bentuk supaya hasilnya berkualiti dan berdaya saing tanpa mengurangkan fungsi asal produk tersebut. Struktur kaedah ini mengambil kira aspek yang kritikal di mana segala maklumat akan diselesaikan berdasarkan penyelesaian kejuruteraan dan ini sekaligus mampu mengurangkan konflik yang dihadapi.

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CHAPTER 1

INTRODUCTION

1.1 General Background

Many design and development approaches commonly utilized nowadays. The solution is often limited by the specific experience of them at hand, thus potentially missing a solution that might be simpler and potentially less expensive. For any given product or process design there are two sort of problems;

1) Solution is generally known

2) Solution not generally known.

If the solution is generally known, it can be found in journals, books and others references resources. Whereby the problem where the solution is not generally known are called inventive problem and often offer contradictory requirement. Most the time in order to resolve contradictory requirement, people will choose a compromised solution, which not all the requirement are met and those are met are not optimized.

An approaches of TRIZ will resolve the conflict and generate new solutions. TRIZ provides means for problem solvers to access the good solutions. The TRIZ researchers have encapsulated the principles of good inventive practice and set them into a generic problem-solving framework. The task of problem definers and problem solvers using the large majority of the TRIZ tools thus becomes one in which they have to map their specific problems and solutions to and from this generic framework as shown in figure 1.1.

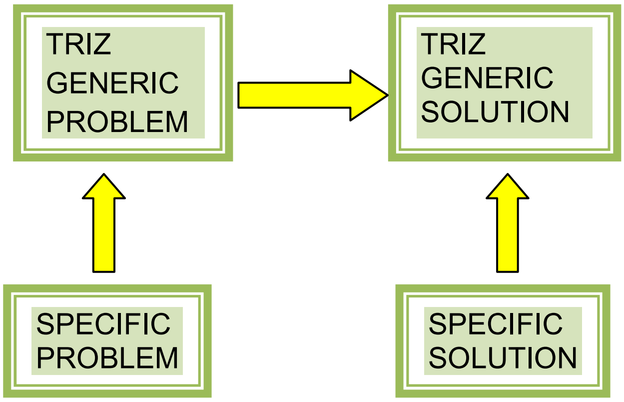

Figure 1.1: The basic TRIZ problem solving process

By using the global patent database as the foundation for the method, TRIZ effectively strips away all of the boundaries which exist between different industry sectors. The generic problem solving framework thus allows engineers and scientists working in any one field to access the good practices of everyone working in not just their own but every other field of science and engineering. Meanwhile Design for Manufacture and Assembly (DFMA) uses a question and answer approach to help determine the most cost effective and efficient assembly method, manufacturing process and materials for a particular product or process. The goal of DFMA is to determine what a product should really cost to manufacture based upon the desired functions of the customer.

The application of DFMA gives engineers the tools for deciding where cost is necessary in a design based upon customer functions, and where cost may be removed by either eliminating components, combining components, or integrating components together to accomplish the same required customer functions. This optimization in achieving the lowest cost for any given product or process may also be accomplished by changing materials or processes to more closely match customer functions. where the highest value is obtained by providing the maximum function at the lowest possible cost.

DFMA may be used to help the design team to simplify the product, improve quality, reduce assembly and manufacturing costs, as well as to quantify the improvements of the design. A second very important use of DFMA, is to study competitors products and processes from a design, quality, material selection, number of components, manufacturing method, point of view and then evaluate assembly and/or manufacturing difficulties in an effort to design a superior product based upon the results of this detailed analysis.

Finally, the third area where DFMA can be used effectively today is to hold suppliers accountable by using DFMA as a 'should cost' tool to provide cost predictions where supplier quotations may be analyzed in detail based upon industry standards for any given product or process. This in turn holds suppliers to a higher standard and will require them to justify their quotations if they don't closely match the results of the DFMA industry generated cost models. The DFMA methodology can be developed and used by various manufacturing organizations to help them generate their own internal 'cost models' which will be able to predict the cost of future products before they are tooled and fully developed.

This is the basic definition of Value which is [1]:

$$\textbf{VALUE} = \frac{\textbf{FUNCTION}}{\textbf{COST}}$$

[1] James D Bolton Utilization of TRIZ with DFMA to Maximize Value 2005

1.2 Problem Statement

Most manufacturing organizations are not utilizing the optimum product development process for the introduction of new or future products. Unfortunately, many of these organizations are still using the 'traditional design'. Solving difficult problems is a complex activity that is governed by the search for knowledge. Problem solving is affected by a combination of the searching process and by the availability of the knowledge required to solve the problem.

1.3 Project Scope

Scope of this project limited to:

- Literature review on product improvement using DFMA and TRIZ approaches.
- Application of DFMA and TRIZ for product improvement.
- Apply DFMA methodology to identify design problems and generate remedial design solutions
- Apply TRIZ method to improve the value added for product development.

1.4 General Objectives

The general objectives of project are:

a) To study and critique the original design product for assembly efficiency
b) To analyze the design assembly efficiency and assembly time of the design
c) To redesign the product in order to improve assembly operations
d) To quantify the benefits of the redesigned part
e) To select a suitable material for each selected part.
f) To select a suitable process for each selected part.
g) To satisfied the reasons for the materials and processes selections.
h) To optimized the manufacturing process and cost.

1.5 Specific Objectives

To apply Design for Manufacture and Assembly (DFMA) and Theory Inventive of Problem Solving (TRIZ) methodology in order to improve and optimize the current product design.

1.6 Significant of Finding

Result of study will give us an overview the advantages of using integration problem solving tool in product development and will attract more organization to use this method for their product development purpose.

1.7 Thesis Statement

The solving approaches of DFMA distinct to two methodologies, ie Design for Assembly (DFA) and Design for Manufacturing (DFM) to develop a total product cost by optimizing the design using the best materials and processes and most of the designer are focusing on these element. So by integrating the TRIZ approach with different methodology the design improvement can be done in maximize value.

1.8 Research Design Process

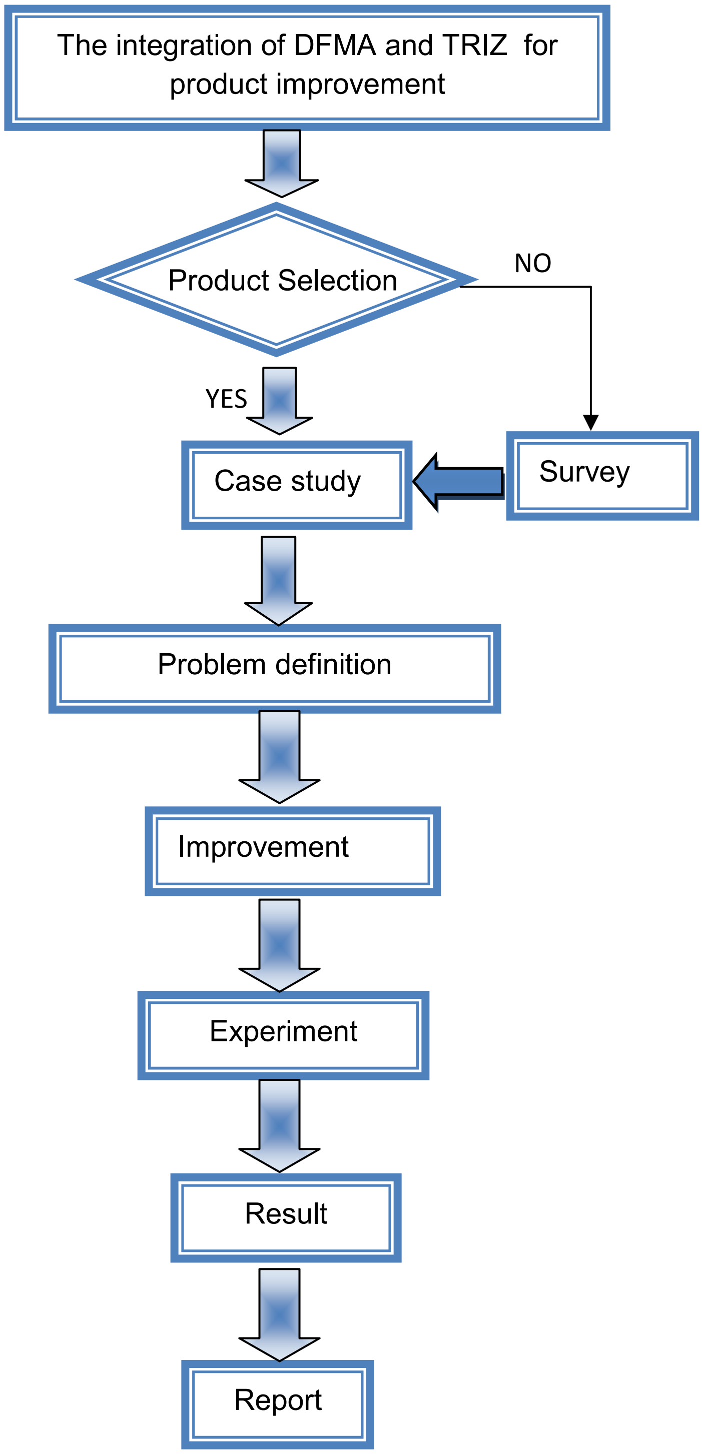

Figure 1.2 : Flowchart of research design

1.9 Research Schedule Planning

PROJECT ACTIVITIES	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18
Evaluate using DFMA		plan																
		actual																
Evaluate using TRIZ																		
Improvement using DFMA																		
Improvement using TRIZ																		
Analysis the result																		
Prepare the report																		
Submit the report																		
Prepare the presentation																		
Presentation																		

1.10 Summary

The integration DFMA and TRIZ will give a better result of product design in simplification product life cycle, efficiency, quality, function and product value. The combination of DFMA with TRIZ can be a very powerful tool for any manufacturing organization in developing new products or optimizing existing products. As stated earlier, it is best to utilize the DFMA tool as early as possible in the design development process for any given product such that the best designs may be developed with optimized materials and processes when considering manufacturability. The TRIZ tool may be used on a variety of problems or when a new inventive solution is necessary and it has evolved into a system that can be the cornerstone of a company's innovation practice. It can be used effectively as an iterative tool with DFMA when the initial analysis does not meet the cost target for a given product as set either internally, by the customer or by market conditions.

Manufacturing organizations today need to be able to apply new technology to their products and processes to be successful in the highly competitive global marketplace, and the usage of TRIZ in combination with DFMA can help them meet the objective. Since TRIZ is effective in product development, the integrations of TRIZ and problem-solving tools to gain competitive advantage and innovation capability are more and more used in industries. Through searching various sources, a general survey of the integration tools, together with their application in the new product development process is presented. Their applications in different industries are summarised. An additional benefit of utilizing these tools has been the improvement of communication between the product design department, advanced manufacturing engineering department, quality department and the suppliers in the early stage of development of a new product.