SOFTWARE DEVELOPMENT OF ASSEMBLY SEQUENCE APPROACH FOR TABLE FAN BY USING INTERGRATED TRIZ, AXIOMATIC DESIGN AND BOOTHROYD – DEWHURST DFA

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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Dedicated to my beloved

Mother, Father and Sister

For their endless support in term of motivation,

Supportive and caring as well throughout the whole project…

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ABSTRACT

Price is one of the important packages that must have in a product so it can be more competent in market. Assembly cost is one of the major operations in manufacturing but always ignored during designing stage. Design is a process that needs creativity of an engineer. Theory Inventive Problem Solving (TRIZ) and Axiomatic Design (AD) is a method which provides guidelines for the designer to design a product. This project is aim to use develop a software by using the integrate approach of AD, TRIZ and DFMA to improve product design process. The software was developed by using Microsoft Visual Basic 6. The result of this research is software named Axiomatic-DFA. Comparative analysis will be done between current and proposed design. Using integration of AD and TRIZ, current design is improved in terms of Design for Assembly (DFA). Current parts will be analyzed using DFA method to know the level of assembly effectiveness. . The assembly effectiveness of current design will obtain, and will be set a datum. Then, integration of AD and TRIZ are used to generate the proposed design. A survey among possible customer is done and translates to the customer domain. Functional requirements are determined to satisfy customer requirement. If FR identified doesn't meet the constrained or coupled, the process will continued with TRIZ method .Using 3 TRIZ tools, the proposed design should be obtained in the end of the analysis. Proposed design is evaluated and selected based on Pugh method. DFA analysis of optimized design is done and comparative analysis is made between the current and proposed design. The final result of the project shows that design efficiency is increased by 108.2 %.The develop software then checked for its validity in terms of its result by comparing to the actual software that is in the market already the Boothroyd-Dewhurst DFA. The comparison shows that the newly-develop Axiomatic-DFA got an accuracy in the range of 94.6-99.4 % in terms of design efficiency

ABSTRAK

Harga adalah salah satu pakej yang penting supaya sesebuah produk mampu bersaing di pasaran. Kos pemasangan adalah salah satu operasi penting dalam bidang pembuatan tetapi selalu diketepikan semasa proses mereka bentuk. Reka bentuk adalah proses yang memerlukan seseorang jurutera menjadi kreatif. Teori Daya Penyelesai Masalah (TRIZ) dan Aksiom Reka bentuk (AD) adalah kaedah yang menyediakan garis panduan kepada pereka untuk mereka bentuk sesuatu produk. Projek ini bertujuan untuk menghasilkan satu perisian dengan menggunakan pendekatan integrasi antara AD, TRIZ dan Boothroyd-DFA untuk menambah baik proses merekabentuk produk. Penghasilan perisian ini di laksankan dengan penggunaan Microsoft Visual Basic 6. Perisian baru ini di namakan Axiomatic-DFA. Analisis perbandingan dibuat antara produk semasa dengan produk yang dicadangkan. Menggunakan integrasi antara AD dan TRIZ, produk semasa diperbaiki dari segi Rekabentuk Untuk Pemasangan (DFA).Produk semasa akan dianalisi menggunakan kaedah DFA untuk mengetahui tahap kecekapan pemasangan. Kecekapan pemasangan untuk rekabentuk semasa akan diperolehi dan dijadikan sebagai penanda. Kemudian, kaedah AD dan TRIZ digunakan untuk mendapatkan produk yang dicadangkan. Kajian dijalankan dikalangan pengguna dan ditafsirkan ke domain pengguna. Keperluan fungsi (FR) ditentukan sebagai penyelesaian kepada keperluan pengguna dalam AD. Jika FR yang dikenalpasti tidak memenuhi kekangan, proses analisis akan diteruskan dengan kaedah TRIZ. Menggunakan 3 keperluan TRIZ, cadangan rekabentuk akan diperolehi diakhir analisis.Cadangan produk ini dinilai dan dipilih berdasarkan kaedah Pugh. Analisis DFA untuk produk yang dipilih dilakukan dan analisa perbandigan dilakukan antara produk semasa dan produk yang dicadangkan. Keputusan akhir menunjukkan kecekepan rekabentuk meningkat sebanyak 108.2 %. Perisian yang baru di hasilkan iaitu Axiomatic-DFA kemudiannya di periksa kesahihan keputusannya dengan di bandingkan bersama perisian Boothroyd-Dewhurst-DFA yang sudah lama berada di pasaran dunia. Perisian baru, Axiomatic-DFA ini mencatatkan keputusan yang mirip seakan perisian lama Boothroyd-DFA dengan kejituan keputusannya di dalam lingkungan 94.6 %-99.4 % dalam perbandingan tahap kecekapan pemasangan.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Price is one of the important packages that must have in a product so it can be more competent in market. There are various factors that can affect price, such as material and assembly cost. assembly is one of the major operations in manufacturing but always ignored during designing stage. As a result, assembly cost will be higher than it should be which directly will make overall cost of product increase. Considering on that factor this paper will aim to propose a framework of developing software that aids the designer as well as the manufacturer in decision making process during the early design stage.

1.2 PROJECT BACKGROUND

Quality and price are the important to the product in order for it to reach market target. As quality is totally general and depends on the product, this project aims to improve design features in terms of price, more specifically assembly cost. Designer always put manufacturing and material cost as a major factor that will affect overall cost of the product with ignoring assembly cost. Assembly efficiency will affect overall time and cost to manufacture the product.
The rapid development of new products has shortened product time-to-market and shelf-life, increasing the quantity of wasted used goods. The assembly process is one

of the most time consuming and expensive manufacturing activities. As the complexity of products and production systems increases, the need for computer mediated design tools that aid designers in dealing with assembly and disassembly aspects is becoming greater (Boothroyd and Alting, 1992). The development of efficient algorithms and computer aided integrated methods to evaluate the effectiveness of assembly sequences is necessary. Efficiency and flexibility to operate with the maximum number of different products, production environment and plant layouts are the main features of these algorithm (Percoco and Spina, 2004).

The assembly sequence is traditionally generated by a human expert who carefully studies the assembly drawing and generates the sequence in his mind. This planning step is very costly and time consuming. Together with time and cost issues, manufacturers are becoming more environmentally sensible. In addition, stricter regulations are forcing manufacturers to become more responsible for the entire product life cycle. (Galantucci; Percoco & Spina 2004).

Boothroyd *et al.* (2002) pointed out that average percentage of part count reduction is 51.4 percent from 43 published case studies in which DFMA methods were implemented. Also average labor costs were cut by 42 percent, assembly time cut by 60 percent, product development cycle time reduced by 45 percent and cost reduced by 50 percent results from assembly parts reduced 54 percent according to DFMA methodology used.

Upon using the DFMA method the output is the efficiency of the assembly sequence and the addition and the implementation of Axiomatic design and TRIZ method will improve the design thus increase the efficiency of the assembly sequence significantly. This is what this paper is trying to achieve base on the current situation of manufacturing world where cost is considered as the most important packages in designing and producing a product.

1.3 PROBLEM STATEMENT

The problem is to determine the validity of the newly-develop software is yet to be determined and the implementation of Axiomatic Design and TRIZ method in the early design stage on decision making process so that the time needed to assemble the product as well as its cost could be reduce. The problem formulations are:

1. The accuracy of newly-develop system is yet to be determined.
2. The newly-develop software still needs to be check for its validity.
3. Does the newly-develop software improves the assembly decision making process at the early stages of the design process.

1.4 RESEARCH OBJECTIVE

The objective of this study is to develop a software for integrated assembly design that aids designer on decision making process in the early design stages.

1.5 RESEARCH SCOPE

This research scope is limited to:

1. A table fan component is selected as a case study.
2. The system is developed by applying integrated Axiomatic design and TRIZ, and Pugh method.
3. Microsoft Visual Basic 2006 6.0 will be use to develop the software.
4. Methodology is based from the previous developed PSM by Mohd Hamidie Bin Hassan.
5. Boothroyd and Dewhurst DFMA are selected as the DFA tool.
6. Two simple case study are selected to check the validity of the newly-develop software.

1.6 CONCLUSION

This chapter described about overall introduction of this project. Background of this project is discussed after defining the problem statement. Then, scopes and objective of this project are the guidelines of this project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will provide reviews of related literature to Design For Assembly (DFA) method. This chapter also discusses about Theory of Inventive Problem (TRIZ), Axiomatic Design (AD).

2.2 THEORY OF INVENTIVE PROBLEM SOLVING (TRIZ)

There are two groups of problems people face: those with generally known solutions and those with unknown solutions. Those with known solutions can usually be solved by information found in books, technical journals, or with subject matter experts. The other type of problem is one with no known solution. It is called an inventive problem and may contain contradictory requirements. In modern times, inventive problem solving has fallen into the field of psychology where the links between the brain and insight and innovation are studied. (Kowalick, J)

Competitions in technologies and services are getting more and more severe in the global scale. In any field of technologies and services, only the ones who could solve current problems by creating new ideas and implementing them quickly can survive. The ability to solve inventive problem is the most basis for organizations and individuals. (Nakagawa, 1999)

Methods such as brainstorming and trial-and-error are commonly suggested. Depending on the complexity of the problem, the number of trials will different. If the solution lies within one's experience or field, such as mechanical engineering, than the number of trials will be fewer. If the solution is not found, then the inventor must look beyond his experience and knowledge to new fields such as chemistry or electronics. Then the number of trials will grow large depending on how well the inventor can master psychological tools like brainstorming, intuition, and creativity. A further problem is that psychological tools like experience and intuition are difficult to transfer to other people in the organization.

That problem is called psychological inertia, where the solutions being considered are within one's own experience and do not look at alternative technologies to develop new concepts. When we considering the limiting effects of psychological inertia on a solution map covering broad scientific and technological disciplines, we find that the ideal solution may lie outside the inventor's field of expertise.(Kowalick, J) This will limit the design or the solution that will obtained which another words can be say, the inventor will lost his creative ability.

The creative ability for individuals and the capability of problem solving for organizations, however, are both abstract capability fundamentally based on human mind. Even highly educated technologists and researchers in various specialties are not always creative enough. (Nakagawa, 1999)

To be creative, the "inspiration" is often required. Individual technologists and researchers are accumulating knowledge’s and experiences in their specialty like chemistry, machinery, computer science, etc. but at the same time they are often losing creative abilities, it is said.. (Nakagawa, 1999) One of solution is TRIZ, the problem creative solution which can guide designer to avoid psychological inertia and be more creative.

2.2.1 Triz Principle

There are six basic tools available for a TRIZ analysis. The six tools are:

a) Contradiction Analysis /system conflict

This tool is most commonly associated with "classical TRIZ". It works for a problem defined as a contradiction that fits in the format of the 39 parameters (problems that are physical contradictions). (Hu and Yang, 1998) Table 2.1 shows all the 39 parameters.

Table 2.1: 39 Engineering Parameters. (Kowalick, J)

1.	Weight of moving object	21.	Power
2.	Weight of nonmoving object	22.	Waste of energy
3.	Length of moving object	23.	Waste of substance
4.	Length of nonmoving object	24.	Loss of information
5.	Area of moving object	25.	Waste of time
6.	Area of nonmoving object	26.	Amount of substance
7.	Volume of moving object	27.	Reliability
8.	Volume of nonmoving object	28.	Accuracy of measurement
9.	Speed	29.	Accuracy of manufacturing
10.	Force	30.	Harmful factors acting on object
11.	Tension, pressure		
12.	Shape	31.	Harmful side effects
13.	Stability of object	32.	Manufacturability
14.	Strength	33.	Convenience of use
15.	Durability of moving object	34.	Repairability
16.	Durability of nonmoving object	35.	Adaptability
17.	Temperature	36.	Complexity of device
18.	Brightness	37.	Complexity of control
19.	Energy spent by moving object	38.	Level of automation
20.	Energy spent by nonmoving object	39.	Productivity

From table 2.1, it can be summarized that there is 39 engineering parameters. This parameter is used to formulate the problem into parameter and will be use in further analysis.

A problem requires creativity when attempts to improve some system attributes lead to deterioration of other system attributes. Such a collision, weight versus strength or power versus fuel consumption, leads to system conflict. Creatively solving such a problem required overcoming the conflict by satisfying all colliding requirements. (Domb and Slocom, 1998) In TRIZ, contradiction had divided into 2:

i) Technical contradiction - Technical contradictions are the cases when there is improvement of one aspect (or a parameter) of the system, some other aspect will degrade and becomes worse. When we want to improve the system in one aspect, the system gets worse in another aspect (Mazur, G). TRIZ, on the other hand, tries to find breakthrough solutions by "eliminating" the contradiction (Mazur, G). In order to represent the situations of technical contradictions, TRIZ has selected 39 parameters of systems and has provided a problem matrix of size 39 x 39. (Hu and Yang, 1998) Figure 2.1 shows example of contradictions table.

ii) Physical contradiction - Physical contradictions are the cases where same elements subject two opposing parameters. The system in problem is requested toward a direction in one aspect, while the same system is requested toward the opposite direction in the same aspect. (Kowalick, J) This means two mutually-opposite requirements to one aspect of a technical system need to be fulfilled at the same time. The situations like this are contradictory and absolutely impossible to solve, in ordinary sense. On the contrary, however, TRIZ advises to reformulate the problems into the form of Physical Contradictions and then has demonstrated that they can readily be solved with "Separation Principles", which separate the problem into two and solve one by one. (Hu and Yang, 1998)

b) Ideality

A second fundamental philosophy of TRIZ is the Ideality Principe, which is that technological systems evolve toward increasing ideality. This tool is one component of