NATIONAL TECHNICAL UNIVERSITY COLLEGE OF MALAYSIA

Product Development Using DFA Methodology

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By

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ABSTRAK

Keuntungan yang tinggi merupakan objektif utama bagi semua pekilang dan ini dapat dilakukan melalui pengurusan kos pengeluaran. Konsep DFA adalah langkah-langkah yang dibangunkan untuk menentukan masalah yang muncul dalam pemasangan. Ia merupakan alat yang amat berguna dalam mengurangkan kos pengeluaran. Dengan ini, banyak kaedah DFA telah diperkenalkan dan Hitachi, Lucas dan Boothroyd-Dewhurst adalah tiga daripada yang dikenali.

Dalam tesis ini, pembelajaran terhadap kaedah DFA dilakukan. Selepas itu, reka bentuk satu produk terpilih dipernilaikan dan direka bentuk semula dengan menggunakan salah satu daripada kaedah DFA. Ini bertujuan meminimumkan kos pemasangannya. Konsep asas kaedah-kaedah DFA ini adalah mengurangkan bilangan komponen di samping memastikan baki komponen adalah mudah dipasang.

Penyelidikan ini mempertunjukkan maklumat-maklumat tentang kaedah DFA dan cara bagaimana melakukannya. Diharap melalui kertas projek ini, pengguna akan menjadi lebih memahami pembangunan berkaitan dengan pemasangan, membandingkan dan memahami kebaikan dan keburukan di antara kaedah-kaedah DFA tersebut.

ABSTRACT

The main objective of every manufacture is to multiply the profit gained from the manufacturing activities and it is to be done by reducing the cost of production. Design for Assembly (DFA) concept is a procedure that developed to be used in systematic way to determine the problem that may arises in assembly. It is one of the most powerful tool for reducing manufacturing costs. In this respect, several DFA methods are introduced by expert in this field. Among all of the design for assembly methods, Hitachi Assemblability Evaluation Method, Lucas DFA Method and Boothroyd-Dewhurst Evaluation Method are three well-known methods.

In this thesis, study towards the DFA evaluation methods has been done. A selected product design is evaluated and redesigned by using one of the DFA method seeks to minimize the assembly cost and time. Basically, it is done by reducing the number of parts and ensuring easy assembling for the remaining parts.

This case study is carried out starting from the literature study and them on how to implement the three different DFA methods. It is hoped that in this case study, all users become familiar with philosophy of assembly, provide useful companion and understanding of the advantages and disadvantages among the DFA evaluation methods

DEDICATION

Firstly I would like to thank to Allah S.W.T for the opportunity to finish this project. I owe this project and my true happiness to my beloved parent. Since the day I started going to this university until today, they are very caring and supporting for me.

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INTRODUCTION

1.1 Introduction

Profit is a very important element in running a company. It can only be obtained when the expanses are managed to be coped up by the total gaining. What is more important and more interested by company is not to discuss on how to obtain the profit but is on how to multiply the profit by reducing the costs of the production. One virtually untapped source of reduced costs was assembly and the most effective method of reducing assembly costs is through good product design. With references to this one of the most powerful tools for reducing manufacturing costs has been introduced, which is the design for assembly (DFA).

Recently, increasing number of companies are taking advantages of the benefit offered by design for assembly approach. These are a few designs for assembly methodologies have been developed, such as Boothroyd-Dewhurst for Assembly Method, Lucas DFA Method and Hitachi Assemblability Evaluation Method and other. These design for assembly methods are presented through a handbooks, monograph, evaluation procedures with spreadsheets and eventually, in computer-aided system.

Among all these design for assembly methods, Boothroyd-Dewhurst for Assembly Method, Lucas DFA Method, and Hitachi Assemblability Evaluation Method are the most well-known. In this thesis, Boothroyd-Dewhurst for Assembly Method is chosen, because it is very simple and easy to apply.

1.2 Problem Statement

Design for Assembly (DFA) is one technique for product development. It is aimed for producing a better quality product. This study will analyses a product using DFA and to propose an improved design. This study will;

i. to define the component that can be reduce
ii. to improve the original component to the new component in the aspect of time and cost of the product assembly

1.3 Objective

The objectives of this study are as follows:

i. To understand how Boothroyd-Dewhurst DFA can be implemented.
ii. To analyses a product using DFA approarch.
iii. To propose an improved product design

1.4 Scope of Study

The scopes of study are follows

i. Use actual product as a sample of case study.
ii. Carry out DFA analyses for product improvement

1.5 Methodology of Study

The methodologies of this study are as follows:

i. Literature review on study the DFA
ii. Select a product identify the component and its function
iii. Understand the methodology used to assemble the product
iv. Analyses the product using DFA
v. Recommended improvement on product design

CHAPTER 2
INTRODUCTION TO DESIGN FOR ASSEMBLY (DFA)

2.1 Introduction

Basic concept of Design for Assembly (DFA) is discussed in this chapter, where the definition and objective of assembly, principle, roles and benefit of DFA are introduced.

2.2 Definition of Assembly

Assembly occurred as soon as two or more component parts are to be brought together in order to produce the finish product. ***(Boothroyd and Redford, 1968).***

Effective assembly is the ability to take the part in an unknown orientation and poorly defined location, by motion in which the only force generated result from these needed grip the part and those that are necessary to mate the part to meet the functionality. ***(G.Boothroyd and Corrrado Poli, 1982)***

Assembly processes compound of handling, composing and checking, which each stand a functional meaning (***Andreasen, Kahler, Lund, 1983***):

1. Handling – process of selection and preparation of components for composing or checking and transportation to be followed by production, assembly or packaging systems.
2. Composing – the aim of which is to create a permanent connection between the components. The composition process can be achieved by means of shape, force or material.

3. Checking – process by which the component's presence and position is checked in addition to the finished product quality. Sub-processes can include handling in addition to special checking operations.

2.3 Objective of Assembly

The objectives of assembly are (***Redford, 1994***):

i. To bring together a number of objects and place them in meaningful spatial and physical relationship relative to each other.

ii. The sequencing of these tasks within constraints imposed by the design such that causes minimizing disruption to the end objective.

iii. This could be defined as minimizing effort until the probability of success in most appropriate, applying effort in a way that minimize cost in the event of failure.

2.4 Designs for Assembly Principles

The principles of DFA are concerned with minimizing the cost of assembly within the constraints by mean to meet fit, form, and function of the assembly. The best way to achieve this minimization is first to value analyze the assembly to reduce the number of parts to be assembled. Next, reducing material cost and to ensure that the remaining parts are easy to assemble and produce, thus reducing assembly time and cost and increase assembly flexibility. This analysis will show if it is more economical to redesign the part with the same function and better reliability than the old design.

The DFA principle includes:

i. Develop sound base component or modular design

ii. Stack assembly is best, but all assembly operation should be in one direction.

iii. Drive the uses multifunctional parts.

iv. Eliminate assembly adjustment where possible.

v. Provide self-locating features where possible to aid the assembly operation.

vi. Provide direct accessibility to all subassemblies.

vii. Standardize fastener, component, and material whenever possible.

viii. Minimize levels of assembly

ix. Facilities handling of parts, avoid orientation, make parts symmetrical, and avoid tangling and nesting problems.

2.5 Roles of DFA

Designer determines the product's structure and the component's design. It is important to remember the degree of freedom at every stage of the design phase, degree which creates the possibility for an optimization of assembly. Therefore, it is important for the designer to bear the principle of design for easy for assembly in mind. From statement above we can conclude that DFA plays an important role in conceptual design stage because product's structure, component design, number of components, choice of material, tolerance, surface finishes, method of assembly and other have been decided during conceptual design stage.

Unfortunately, most of the designers take no great notice of the important of DFA. This is due to:

i. Lacks of realization as to important of assembly

ii. Lacks of knowledge of design for assembly

iii. Lack of time

iv. The habit of saying "they usually work it out in production and etc.

2.6 DFA Benefits

Assembly would cause more than 50% of the total manufacturing costs. Recently, many companies try to implement DFA method to reduce their production cost, so that they can lead the market and make more profit in today's competitive business world. Some of DFA benefits are listed below:

i. High profitability

Decrease in manufacturing cost often represents a very high percentage increase in profit because profit margin is often every small percentage of costs. Statistical surveys shows that 20 to 30 percent of assembly cost can be eliminated by successfully implemented DFA (***William Wai – Chung Chow, 1978***). The reduction of assembly costs through DFA is due to:

- Eliminate assembly- eliminate the number of parts to be assembled will reduce the assembly costs.
- Avoid variants – larger quantities of similar parts can be assembled on the same operations/equipments in order to reduce the total time needed for assembly.
- Maintain the uniformity of variations in assembly – the size of the production in assembly will be increased as the instruction, conversion, the number of components, etc. in the assembly system can be reduced when the uniformity of variation in assembly is to be maintained.

ii. High productivity

DFA methods tried to simplify product design through minimize the number of parts, so it needed less operations to assemble one unit of product. This would reduce assembly time and increases the productivity.

iii. High quality of product

Assembly is sensitive to alternation and variation in the characteristics or quality of components. Testing and checking of components and subassembly is a problem which must be included at an early stage of the deliberations on product structuring. Since DFA tried to make assembly as simple as possible, so that numbers of failures due to assembly would reduce. This also means that quality of product would increase.

2.7 Summary

Design for Assembly (DFA) is a central element of design for manufacture (DFM). It is playing a role in DFM as a structure methodology for evaluating the efficiency of part design and assembly systems. The potential of DFA is high as it brings a lot of benefits if it is correctly implemented. However, the actual objective of every design and manufacturing engineer is to discover a tool, where the manufacture and assembly of the finished product can be considered simultaneously.

CHAPTER 3

DESIGN FOR ASSEMBLY METHODOLOGIES

3.1 Introduction

Three well-known DFA methodologies are discussed in this chapter, namely Boothroyd-Dewhurst DFA Method, Hitachi Assemblability Evaluation Method and Lucas DFA Evaluation Method. The concept, principle, implementation method and procedure of those are thoroughly explained. The ending topic of this chapter is the comparison of these three DFA methods.

3.2 General Characteristic of DFA Methodologies

In the last 20 years, many commercial DFA methodologies have been developed and increasing number of companies are taking advantages of the benefits offered by their use. However, these DFA methodologies do not offered the user the relationship between the various technologies and the guidelines that would help the user appreciate as well as use the rules. A few characteristics must be understood in order to create an environment where the users can be more familiar with the philosophy of assembly rather than just the mechanics of assembly design. This will then lead understanding of DFA and subsequently better design. The characteristic are: (***Redford and Chal, 1994***)

i. Complete

The method should have two complementary parts:

- Objectivity – procedure for evaluating assemblability.
- Creativity – procedures for improving assemblability.

Designer must know how to change or influence factors since knowing that thing is wrong are not naturally lead to things that are right.

ii. Systematic

This characteristic indicates that the methodology involves step-by-step procedures, which helps to ensure that all relevant issues are considered.

iii. Measurable

One of the major problems of DFA is how to measure assemblability objectively, accurately and completely. The goal of assemblability evaluation is to find the optimal combination of influence fact

iv. Easy to used and effective

A very fine balance is necessary between the cases of use and the quality of the design exercise. This is because as design and manufacturing engineers are typically operate to very tight schedules, they do not want to spend too much of time for learning a DFA method. So, DFA method must easy to use and be effective.

3.3 DFA Methodologies

It is impossible to generate to generate a standard DFA methodology for all kinds of assembly industries because the processes involved in different industries are very customized. As a result, there are a number of DFA methodologies that have been developed as explained below:

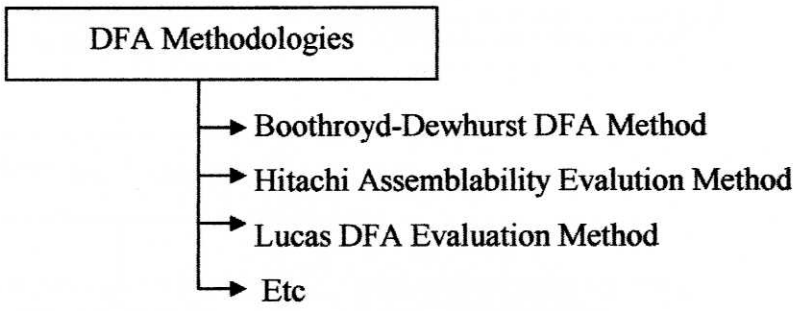

Figure 3.0: List of DFA Methodology

3.3.1 Boothroyd-Dewhurst DFA

One of the developments by Boothroyd-Dewhurst Ins. The Design for Asemmbly (DFA) methodologies. The Boothroyd-Dewhurst Design for Assembly (DFA) methodologies skillfully covers two important elements of the design activity. It allows meaningful quantitative judgments to be made and, very importantly, it gives the user the opportunity to view easily the redesign option available.

The objective for developing the method is to overcome the problem of:

i. Determine the appropriate assembly method
ii. Reducing the number of individual parts that must be assembled, and
iii. Ensuring that the remaining parts are easy to assemble