UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)

BORANG PENGESAHAN STATUS TESIS*

JUDUL: RE-DESIGN OF A PRODUCT USING BOOTHROYD DFA APPROACH

.

SESI PENGAJIAN: 2008/2009

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DECLARATION

I hereby, declared this report entitled "Redesign of a Product Using Boothroyd DFA Approach' is the result of my own research except as cited in references.

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Author's Name: Nurul Ain Binti Ismail

Date : 10 April 2009

APPROVAL

This PSM submitted to the senate of UTeM and has been partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design). The member of the supervisory committee is a follow:

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Mr. Ismail Abu Shah
Project Supervisor
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ABSTRACT

In the recent time, design for assembly, DFA is quite important according the current issue about the increasing price of the product at the market. DFA is considering and resolving the possible problems in the assembly process at the early stage of the design which can make sure the part will be assembled will high speed, low cost and productivity. According to this approach, the aims of this project try to simplify the product and also reducing the number of parts and cost. Besides that, to minimize part numbers, part variety, assembly surfaces, simplify assembly sequences, component handling and insertion, for faster and more reliable assembly. To realize this project, with using fused deposition machine to produce a physical object of re-design using RP process. Before that, this project must be through it with the DFA analysis by carry out the Boothroyd DFA approach. This project focuses to simplify the product structure of the product and get the new re-design of the product with using the manual assembly process method to carry out DFA analysis.

ABSTRAK

Pada masa kini, rekabentuk produk untuk pemasangan sangat penting berikutan dengan isu semasa yang berkaitan dengan kenaikan harga barang di pasaran. Pada peringkat permulaan lagi, rekabentuk produk untuk pemasangan dikenalpasti masalahnya dan mencari jalan penyelesaiannya. Ini adalah untuk memastikan bahagian yang perlu dipasang dengan kadar yang cepat serta dapat mengurangkan kos dan sekaligus meningkatkan produktiviti penghasilan produk tersebut. Berikutan dengan itu, tujuan utama kajian ini dijalankan adalah untuk meringkaskan rekabentuk produk tersebut. Dan dalam masa yang sama, untuk mengurangkan bilangan bahagian produk dan kos. Sementara itu, melalui kajian ini juga, untuk mengendalikan pengelolaan dan sisipan secepat yang mungkin. Untuk merealisasikan projek ini, dengan menggunakan teknik ' rapid prototyping' melalui mesin ' fused deposition machine', untuk menghasilkan produk yang direkebentuk semula. Sebelum melalui proses ini, ia perlu melalui proses analisis iaitu dengan menggunakan pendekatan 'Boothroyd DFA'. Projek ini memfokuskan bagaimana untuk mengurangkan bahagian pemasangan produk dengan cara menggunakan teknik rekabentuk semula produk dengan menggunakan pendekatan pemasangan secara manual untuk menghasilkan analisis tersebut.

DEDICATION

For my beloved family:

Ismail Bin Muhaiyiddin

Noraida Binti Mohamed Sabri

Muhamad Faisal Bin Ismail

Muhamad Fairuz Bin Ismail

Farzana Binti Ismail

Muhamad Firdaus Bin Ismail

Anis Farhani Binti Ismail

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LIST OF ABBREVIATIONS AND SYMBOL

%	-Percentage
£	-
3D	-3 Dimension
ABET	-Accreditation Board for Engineering and Technology
AEM	-Assembly Environment Method
BOM	-Bill of materials
CE	-Concurrent Engineering
CAD	-Computer Aided Design
DFMA	-Design For Manufacturing And Assembly
DFA	-Design For Assemble
DFM	-Design For Manufacturing
DFx	-Design for X
EM	-Design Efficiency
FPDM	-Flat Panel Display Measurement
HTS	-Secondary Technical School
JIT	.-Just In Time
LISP	-Computer Programming Languages
mm	-Millimeter
NM	-Theoretical minimum number of parts
PC	-Personal computer
PDM	-Product Data Management
PCB	-Printed Circuit Board
PSM	-Projek Sarjana Muda
RP	-Rapid Prototyping
Sec	-Second

TM	-Total manual assembly time / operation time
UK	-United Kingdom
UTeM	-University Teknikal Malaysia.Melaka

CHAPTER 1
INTRODUCTION

This chapter provides the background of the project that includes overview of the product suggestion, problems statement, objectives, scope and importance of the study.

1.1 Project Background

Nowadays, design for manufacturing and assembly, DFMA is quite important according the current issue about the increasing of the price for consumer's good. Besides that, the highest price of the petrol and diesel at the market also give effect to consumer especially who have a lower income per month. If this problem still going on, maybe it will make hard for consumer to get the things that they require. For example, when they need to buy something, consequently will spend a lot of money to have it.

The term DFMA comes with the combination of DFA (design for assembly) and DFM (design for manufacturing). The basic concept of it is that the design engineers apply the DFMA paradigm of software to analyses the manufacturing and assembly problems at early design stage. By this means, all of consideration about the factors that affect the final outputs occurs as early as possible in the design cycle. The extra time spent in the early design stage is much less the time that will be spent in the repeat redesign. And meanwhile, the cost will be reduced.

DFA is considering and resolving the possible problems in the assembly process at the early stage of the design which can make sure the part will be assembled will high

speed, low cost and productivity. DFA is a kind of design paradigm with which, the engineer use all kinds of methods such as analyze, estimating, planning and simulating to consider all the factors that will affect the assembly process during the whole design process; revise the assembly constructions to satisfied the characteristics and functions of the final product and meanwhile, lower the cost as most as possible.

The aim of design for assembly (DFA) is to simplify the product so that the cost of assembly is reduced. However, consequences of applying DFA usually include improved quality and reliability, and a reduction in production equipment and part inventory. These secondary benefits often outweigh the cost reductions in assembly. Besides that to minimize part numbers, part variety, assembly surfaces, simplify assembly sequences, component handling and insertion, for faster and more reliable assembly. Furthermore, it also to reduce the total material cost, simplifies vendor selection, reduces labor content and assembly. It also simplifies the assembly process and factory layout.

Thus, DFA is one of is important particularly in manufacturing industry. Since it is one of the major sectors that contribute our country's economy and also gives opportunity to those who need a job. DFA has been most widely applied in industries with most impressive achievements. Since the prevalence of two well-known DFA tools Boothroyd–Dewhurst DFA and Lucas DFA in industries, significant developments have been attempted in several directions.

DFA also standardize on material usage, components, and aim for as much off-the-shelf component as possible to allow improved inventory management, reduced tooling, and the benefits of mass production even at low volumes. Standardize on materials, components, and subassemblies throughout product families to increase economies of scale and reduce equipment and tooling costs. Employ modularity to allow variety to be introduced late in the assembly sequence and simplify JIT production. For example, by replacing four different screws with two identical ones, e.g. in connection to development of a new product generation, one might cut the labour cost and the

material cost in half, reduce investment in feeding and screwing tooling to one-fourth, and at the same time reduce the production lead time.

This project mainly focused to re-design of a product by using the Boothroyd DFA approach. The method used, because it provides a process of improving a product design for easy and low cost assembly. Besides that, it also focused on functionality and assemblability concurrently. For Boothroyd method, it will analyze whether the part can be considered a candidate for elimination or combination with other parts in the assembly.

At the end of this research, the best design of product will be determined by using the Boothroyd DFA approach. The design of product can minimize the number of parts in an assembly also ensure that the remaining parts are easy to assemble.

1.2 Overview of the Product

Figure 1.1: pencil sharpener

In this project, pencil sharpener has been chosen for the study. It is also referred to as pencil pare is a device for sharpening a pencil's point by shaving one end. Pencil sharpeners exist in both electric and hand-powered forms

1.2.1 History Of Pencil Sharpener

Pencils were in use before the development of devices specifically to sharpen them. Previously, they were sharpened by shaving with a knife. Pencil sharpeners made this task much easier and gave a more uniform result. Some specialized types, such as a Carpenter's Pencil are still usually sharpened with a knife, due to their flat shape, though recently a fixed-blade device with a relatable collar has become available.

Bernard Lassimone, a French mathematician, applied for the first patent (French patent #2444) on pencil sharpeners in 1828. In 1847, Therry des Estwaux invented the manual pencil sharpener. Electric pencil sharpeners for offices have been made since at least 1917.

They now come in a wide array of colors and shapes. Now, it is common for traditional sharpeners to have a case around them so that the shavings do not fall; you can then remove this and empty the case.

1.2.2 Types of Pencil Sharpener

Handheld barrel pencil sharpener

handheld metal pencil sharpener

Manual double hole cylinder pencil sharpener

battery operated pencil sharpener

Modern pencil sharpener

1.3 Problem statement

Due to the current product design, the number of part counts of a product which too many will cause higher cost of a product. Therefore, to reduce the quantity of part, it will help to lower the product cost and at the same time the quality of the product is maintained.

1.4 Objectives

The objectives of this project are:

a) to simplify the design of the product
b) to quantify the outcomes in terms of cost, lead time and parts count
c) To re-design the product with rapid prototyping (RP) as physical validation method.

1.5 Scope of Study.

By using the Boothroyd Design for assembly approach

a) Using DFMA approach manual assembly to carry out DFA analysis
b) The analysis is broken down into two categories which is handling and insertion or fastening time
c) Using fused deposition machine to produce a physical object of re-design using RP process

1.6 The Importance of Study

The advantage of this provides a systematic procedure for analyzing a product design from the point of view of assembly. This procedure results in simpler and more reliable products that less expensive to assemble. In addition, any reduction in the numbers of parts in an assembly produces a pencil sharpener effect on cost reduction because of the drawings and specifications that are no longer needed, the vendors that are no longer needed, and the inventory that is eliminated. All of these factors have an important effect on overheads, which in many cases; form the largest proportion of total cost of the product.

DFMA tools also encourage dialogue between designers and the manufacturing engineers and any other individuals who play a part in determining final product costs during the early stages of design. This means that teamwork is encouraged and the benefits or simultaneous or concurrent engineering can be achieved.

CHAPTER 2
LITERATURE REVIEW

2.1 Historical background

Engineering design is a process of developing a systems, component, or process to meet desired needs. The means of design is a complex iterative creative process that uses available resources, energy and technology to fulfill the original need within some set of defined constraints. It is a decision making process in which basic sciences, mathematics, and engineering technologies are applied to convert resources optimally to meet a stated objective (ABET, 1988). Engineering design had usually been completed purely based on the consideration of product functionality. The design was then passed from the design department to the assembly process-planning department and then to the manufacturing department. These activities were completed in a sequential manner with no feedback given to the designer. Sometimes the designed product is extremely difficult to manufacture and the manufacturing cost is unnecessarily high.

2.2 History of Design for Manufacturing / Assembly (DFM, DFA, DFMA)

Assembly has been studied seriously for only the past 30 years or so, in contrast to basic fabrication processes such as metal cutting, casting, grinding, and forging. The latter processes involve large amounts of power and high investment and thus attracted the attention of factory managers and researchers almost as soon as they came into use. Assembly has traditionally bee performed by people, and their ingenuity makes up for

many shortcoming in product and assembly process design. Only when automatic machinery and especially robots began to be considered for assembly did it become obvious that more attention needed to be paid to assembly itself.

The basic goals of DFM and DFA are to make fabrication and assembly easier, less costly, simpler, more reliable, and on. To achieve these goals, engineer must often modify their designs and expand their focus when designing so that factors other than product performance are seriously taken into account. Many engineers think that considering manufacturing or assembly will compromise product performance, and often they do not know enough about manufacturing and assembly to make the appropriated changes in their designs in order to achieve DFx goals. If engineers can carry out their own DFx analyses, they can protect product function and will probably learn that there is little chance that function will be seriously impaired. (Whitney,2004)

DFx in the large deals with issues that require consideration of the product as a whole, rather than individual parts in isolation, and likely will require consideration of the context in the factory, supply chain, distribution chain, and the rest of the product's life cycle and will be focus to (a) product structure and its relation to product simplification and (b) design for disassembly, repair, and recycling.

2.2.1 Product structure

Product structure involves many of the issues normally associated with product architecture, but the focus is on the structure more than on its influence on architecture issues. (Andreasen et al, 1983), clearly recognize the close connection, not only between DFA and product structure, but between these two topics and the larger issues of product development process themselves. Early consideration of assemble ability inevitably turns to opportunities for restructuring the product, and this cannot be done not permit early consideration of assembly issues will therefore be very different process from one that does, and the resulting product will be different as well.

Furthermore, the differences will extend beyond the local issue of assemble ability. Figure 2.1 show the example of stack and array product structures

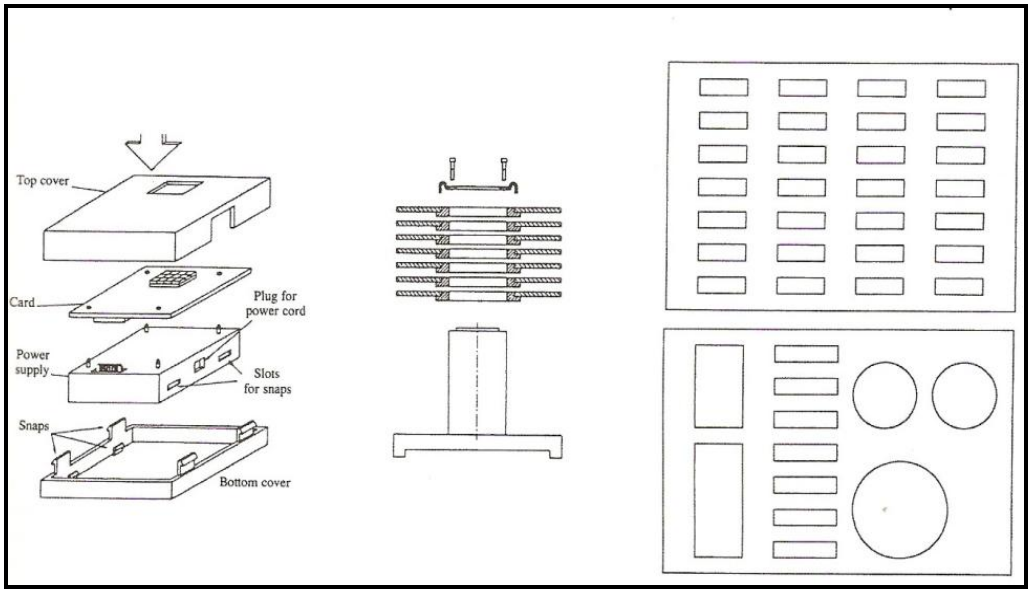

Figure 2.1: Both stacks and arrays come in two generic varieties: the part are mostly the same or mostly different. (Redford and Chal) copyright © Alan Redford

a) Simplification methods

As noted earlier, a major effort of DFA is product simplification. Simpler products have fewer parts, which mean fewer assembly operations, workstations, factory space, and workers. In addition, each part represents design effort and overhead. Whether, simpler/fewer always means less expensive is a separate issue discussed below.

While most researchers and practitioners of DFA understand the desirability of reducing the number of parts, only the Boothroyd method presents a systematic approach to doing this. The idea is to subject each part to three criteria that might justify its inclusion in the product, and eliminate any part that fails the criteria.