"I hereby declare that I have read this report and in my opinion this report is qualify to be awarded the Degree of Bachelor Mechanical Engineering (Design & Innovation)

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Date : 8 MAY 2007

DESIGN FOR MANUFACTURE AND ASSEMBLY (DFMA) EVALUATION OF CAR AUDIO FRONT PANEL

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This report is submitted to the Faculty of Mechanical Engineering
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ABSTRACT

Design for Manufacturing and Assembly (DFMA) is a technique for reducing the cost of a product by breaking the product down into its simplest components. This paper is a detailed study which on the improvement of car audio front panel by using the DFMA approach. The Boothroyd-Dewhurst which concentrates on manual assembly methodology was used for the analysis of the existing product design in order to simplify and reduce the number of parts. Based on the assembly worksheet analysis of the current design, the number of parts for the current design is 25 parts with the number of operation assembly is 32. The time needed to complete assembly the current product is 146.12 seconds. Meanwhile, the assembly cost for the current product is 5.86 cents. As a result, the design efficiency for the current design is 20%. To ensure that the improvement of the current design is achieved, the analysis for the improved design must be made using the Boothroyd-Dewhurst method. Based on analysis done, it is found that the number of parts for the improved design can be reduced to 16 parts with the number of operation for the product assembly is reduced to 18. In order to assemble the current design, the time needed is 71.97 seconds. In the meantime, the assembly cost for the improved design is 2.89 cents. It is found that the design efficiency for the improved design is 67%. The comparison between assembly worksheet analysis for the current design and the improved design are also made to obtain the percentage of improvement. Therefore, the improvement in term of the number of parts is 36%, 50.7% improvement in assembly time, 50.7% improvement in assembly cost, 43.8% improvement in the number of operation and 70% improvement in design efficiency.

ABSTRAK

Rekabentuk untuk Pembuatan dan Pemasangan *(DFMA)* adalah teknik untuk mengurangkan kos produk dengan mempermudahkan komponen-komponen yang terdapat di dalam produk tersebut. Teknologi *"DFMA"* ini boleh membawa kepada pengurangan jumlah komponen sehingga menjadikan produk tersebut mudah untuk dikendalikan dan dipasang semasa proses pemasangan produk. Tesis ini adalah kajian terperinci yang membahaskan tentang pembaikan ke atas panel hadapan audio kereta dengan menggunakan pendekatan *"DFMA"*. Sehubungan dengan itu, kaedah Boothroyd-Dewhurst yang lebih berfokus kepada pemasangan manual telah digunakan untuk mempermudahkan serta mengurangkan jumlah komponen produk yang sedia ada. Berdasarkan keputusan analisa lembaran kerja pemasangan bagi produk yang sedia ada, jumlah komponen yang terdapat pada produk tersebut adalah sebanyak 25 komponen dengan melibatkan sebanyak 32 operasi dalam pemasangan produk tersebut. Masa yang diperlukan untuk pemasangan produk pula adalah sebanyak 146.12 saat. Manakala bagi kos pemasangan produk adalah sebanyak 5.86 sen. Oleh yang sedemikaian, kecekapan produk bagi produk yang sedia ada adalah sebanyak 20%. Bagi memastikan pembaikan terhadap produk yang sedia ada tercapai, analisa terhadap rekabentuk baru produk perlulah dilakukan dengan menggunakan kaedah Boothroyd-Dewhurst. Justeru itu, merujuk kepada analisa yang telah dibuat, didapati jumlah komponen bagi produk tersebut telah dikrangkan kepada 16 komponen dengan jumlah operasi yang terlibat ialah sebanyak 18 operasi. Masa pemasangan produk yang diperlukan pula adalah sebanyak 71.97 saat. Manakala bagi kos pemasangan produk adalah sebanyak 2.89 sen. Selain itu, didapati juga kecekapan produk bagi rekabentuk baru produk adalah sebanyak 67%. Perbandingan di antara rekabentuk lama dan rekabentuk baru produk juga dibuat bagi mendapatkan peratusan pembaikan. Justeru itu, peratusan pembaikan dari segi jumlah produk ialah 36%, masa pemasangan; 50.7%, kos pemasangan; 50.7%, jumlah operasi; 43.8%, dan kecekapan rekabentuk meningkat sebanyak 70%.

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CHAPTER 1

INTRODUCTION

The history of Design for Manufacturing and Assembly (DFMA) actually begins before the Second World War. Ford and Chrysler was used the DFM philosophy to design and manufacture their weapons, tanks and other military products.

The early and significant work on DFM and DFA are mostly begins in the early 1970s. The first persons that make the research job in this technology are Dr. Geoffrey Boothroyd and Dr. Peter Dewhurst, until in 1982 they were founded the Boothroyd Dewhurst, Inc. (BDI). *(Xiaofan Xie. 2006)*. They created and developed the DFMA concept and use it in developing the products of their company such as the DFMA software system. Meanwhile, their company was trademark by the "DFMA".

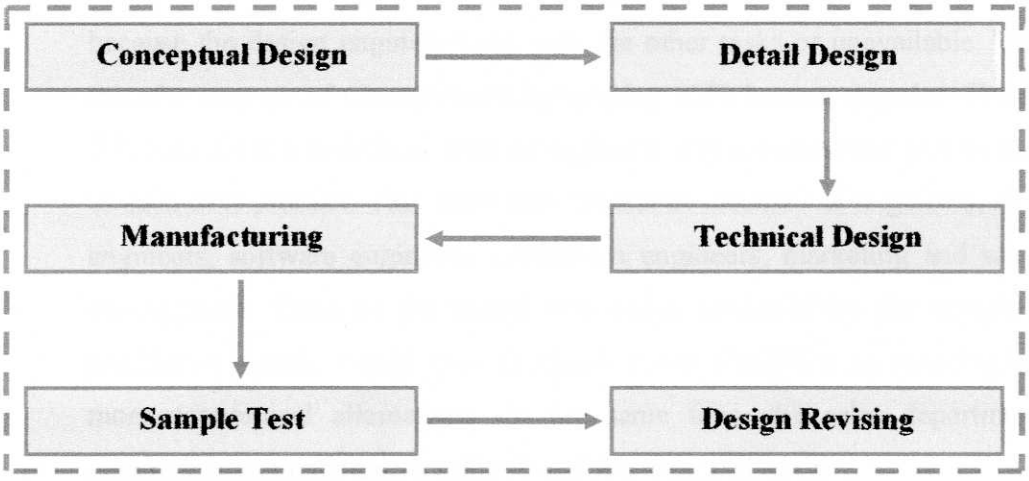

Figure 1.1: Traditional manufacturing process. *(Xiaofan Xie. 2006).*

Figure 1.1 shows the traditional manufacturing process. The design engineers will create the detail drawing while assembly engineer create the assembly plan base on the conceptual design of the parts. After the detail drawing and the assembly plan was created, the prototype will be produced then make a sample test on it. According to the sample test the workshop then gives a feedback to the design engineers and assembly engineer about the prototype and the result of the sample test. The design engineers and assembly engineers will use that information to redesign the product, the assembly plan and the manufacturing process. The same cycle repeats again and again until arriving at competitive design.

However, there are two things were changes in 1970's *(Otto. and Wood. 2006)*:-

i) Many new types of plastics were developed, and injection molding technology became widely used because the possibility of low cost plastic components. Beside that the plastic materials also provided different material behavior. For example, many cycles of large elastic deformations without failure are a property useful in making snap-fit mating components. Thus parts that had to be made form metal and screwed together could just be made out of plastic and snap fitted.

ii) Several companies try to bring their products to the market faster. However, when each time there was a design change made by the manufacturing engineer; product development will hold up and waiting for the Engineering Change Notice (ECN) to be approved by the designer. Often, this process will be delays because the design engineer busy with the other tasks or unavailable. To avoid this, the concept of ***Concurrent Engineering*** **(*CE*)** became popular. The idea of this concept is a combined team of engineers and management will be assigned to each new product. This team may consist of mechanical engineers, electrical engineers, software engineers, production engineers, marketing and sales, and management. Thus, as the design was being generated by the designers, the production people would give feedback about feasibility to manufacture and more economical alternatives. At the same time, the sales department will negotiate about the product outlook and features, and so on.

Nowadays, DFMA is widely used in almost all industrial fields especially in the product design and development. It is commonly used to make an improvement in the design of the existing product including printed circuit boards, manual assembly, robotic assembly, and machining. Beside that, most of the companies today realize that the DFMA methodology is very important in manufacturing and assembly because it can give a big impact in the product design efficiency, the number of parts, time of product assembly, and cost to manufacture the product.

The main goal of DFMA is to lower product cost by examining the product design and structure at the early concept stages of a new product. At the same time, the design engineers also have to consider all of the factors that affect the final outputs 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 repeatedly redesign. DFMA also leads to improvements in serviceability, reliability, and quality of the end product. It minimizes the total product cost by targeting assembly time, part cost, and the assembly process in the early stages of the product development cycle. Beside that, DFMA allows for improved supply chain cost management, product quality and manufacturing, and communication between Design, Manufacturing, Purchasing and Management. The life of a product begins with defining a set of product needs, which are then translated into a set of product concepts. Design engineer will takes these product concepts and refines them into a detailed product design. To be truly successful, the DFMA process should start at the early concept development phase of the project. True, it will take time during the hectic design phase to apply DFMA, but the benefits easily justify additional time.

Therefore this project is a highly regard as fully related to the DFMA and has been developed based on DFMA methodology. The title of this project is ***Design for Manufacture and Assembly (DFMA), Evaluation of Car Audio Front Panel.***

1.1 Objective

The main objective of this project is to improve the design of the car audio front panel in term of the product design efficiency, the number of parts, the product assembly time, and manufacturing cost of the product. In order to make the improvement, the DFMA approach is applied to analyze the existing product.

1.2 Scopes

The scopes of this project are set at early stage of the project to ensure that the objective of the project can be achieved. The scopes for this project are:-

i. Study the concept and methods of DFMA.
ii. Analyze the methods of manufacturing and assembly of the existing product.
iii. Improve the car audio front panel design by using the DFMA methodology analysis.
iv. To propose a new design based on analysis made.