SUPERVISOR DECLARATION

"I hereby declare that the quality of the dissertation written is sufficient for the award of Bachelor of Mechanical Engineering (Design & Innovation)"

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Date : 2/7/2012

DESIGN AND FABRICATION MODULAR PRODUCT WITH THE INCORPORATION OF DIY ASSEMBLY METHOD: LAZY CHAIR

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DECLARATION

"I hereby declare that the work in this dissertation is my own except for summaries and quotations which have been duly acknowledge"

Signature	: ....
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Dedicated with love,

To my parents,

Azmi bin Hj. Arshad and Roziah binti Hj. Mustapha,

To my sister,

Nur 'Asyikin binti Azmi,

To all my friends.

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ABSTRACT

The objective of this project is to study the activities in designed involved in designing of a new modular product concept for 'Lazy Chair' and fabrication of a prototype of scale 1:2 using sustainable material. The modular product also incorporates 'DIY' assembly method. The project starts by choosing a benchmark design and from there; ideas for concept designs were created. Morphological chart was used as one of the method to generate concept designs. Concept selection method was used to choose the final concept design; example is Pugh method. The final concept design is analyzed using DFMA method to compare with the existing design of lazy chair. DFMA is used as a tool for reducing the number of individual parts that must be assembled and increase the ease of put the parts together. The DIY assembly method is the most important part and the best joining method will be determined using the concept selection method. The DIY method is implemented in this design is to make the assembly process of the product easy to conduct with or without the help of a user manual. The outcome of this project is a new modular product concept for 'Lazy Chair' that overcomes several problems that encounters with the existing design.

ABSTRAK

Objektif projek ini adalah untuk mengkaji aktiviti – aktiviti yang direka bentuk yang terlibat didalam proses mereka bentuk konsep modular produk yang baru bagi 'Kerusi Malas' dan fabrikasi sebuah prototaip dengan skala 1:2 menggunakan bahan mampan. Modular produk yang baru ini juga harus menggabungkan konsep pemasangan 'DIY'. Projek ini bermula dengan memilih sebuah kerusi malas sebagai penanda aras dan idea-idea untuk reka bentuk konsep yang baru dapat dihasilkan. Carta morfologi digunakan sebagai salah satu kaedah untuk menghasilkan beberapa konsep rekabentuk yang baru. Kaedah pemlihan konsep yang digunakan adalah kaedah Pugh. Konsep reka bentuk yang dipilih akan dianalisis menggunakan kaedah DFMA untuk melakukan perbandingan dengan reka bentuk kerusi malas yang sedia ada. Analisis DFMA adalah salah satu cara atau aplikasi yang digunakan untuk mengurangkan bilangan bahagian atau komponen yang perlu dipasang menjadi satu produk dan meningkatkan kadar pemasangan yang mudah. DIY adalah bahagian yang paling penting dan cara pemasangan yang terbaik akan dipilih menggunakan kaedah pemilihan konsep yang ada di dalam Reka bentuk Kejuruteraan. Kaedah pemasangan DIY diaplikasikan di dalam reka bentuk ini adalah untuk member kesenangan kepasa para pengguna untuk memasang tanpa memerlukan bantuan manual. Hasil daripada projek ini adalah menghasilkan sebuah konsep modular produk yang baru untuk 'Kerusi Malas' bagi mengatasi beberapa masalah yang wujud dengan reka bentuk yang sedia ada.

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CHAPTER 1

INTRODUCTION

1.1 Background

Figure 1.1: Current Design of Lazy Chair

Chair is created as furniture that is used to sit on normally by a single person. Chair has been invented centuries ago and most often the chair is supported by four legs and has a back. However, the designs are different according to the creativity of the designers and criteria of the chair itself. There are various types of chair and one of the chairs is lazy chair or can also be called leisure or relaxing chair. This type of chair is for relaxing and the person that sits on it can take a nap as the back of the chair is inclined and gives comfort to the user. It differs from other chairs because of the slant angle of the back of the chair.

Lazy chair in this project is design to counter several problems from its original design in terms of assemble the product. Using the modular product concept, a new concept design will be produced to overcome the problems. In general, modular product can be defined as an assembly with reduced parts, less complicated and easy to assemble. Modularization is a concept that offers competitive advantage to overcome complexity. Instead of manufacture a product with plenty of parts and mechanical fasteners, design a product using simple blocks which is easy to manufacture and use less joining method. The customers will be more satisfied and pleased with the easiness of assemble the product (Lupton 2006).

When the customers assemble the product themselves, the terms used for that act is Do It Yourself (DIY) method. DIY is an act of building or modifying without the help of any expertise and instead do it independently. Usually products with DIY assembly method will provide a manual for the customers to follow and DIY products are easy to assemble and use low cost tools (Howell 2010).

1.2 Objective

To study the activities in designed involved in designing of a new modular product concept for "Lazy Chair" and fabrication of a prototype of scale 1:2 using sustainable material. The modular product also has to incorporate "DIY" assembly method.

1.3 Scope

1. To propose few concept designs of modular product.
2. To produce detail design of the selected concept using CATIA V5R16.
3. To analyze the proposed concept design by using DFMA method.
4. To find the best joint method that meets the DIY assembly method.

1.4 Problem Statement

The existing design of lazy chair does not imply the DIY concept. The chair already builds and joints completely and the buyers have to bring the chair in one piece. The chair inclination level can be adjusted according to the user's wish. The tricky part is that both of the arm rest must be moved simultaneously in order to change the inclination level. New modular conceptual design of lazy chair with the incorporation of DIY method will be produced at the end of this project to overcome problems of existing design.

1.5 Methodology

Methodology generally is a guideline for solving problems. In this project, there are several methods used to complete the design of new product. From the first steps until the end, the methods are represents in flow chart to make it easy to understand.

1.6 Outline of Report

Chapter 1 – Introduction

This chapter contains the background, objectives, scope and problem statement of the project. This chapter also reviews generally about the methods used in this project.

Chapter 2 – Literature Review

This chapter reviews the details of subjects cover in this project. The first subject is modular product and followed by DIY assembly method, DFMA, chair, materials and Screw, Bolt and Nut.

Chapter 3 – Methodology

This chapter contains the methods used in completing the project. The flow chart of this project is included in this phase and the details of each methods used is discussed.

Chapter 4 – Concept Generation

This chapter shows several of the concept designs generated from the previous morphological chart (In Chapter 3). The descriptions of each concept designs are also stated in this chapter.

Chapter 5 – Concept Design Selection

This chapter reviews the method used in selecting the best concept design. There are several methods that can be used, but in this project, the author chose Pugh Method as the concept design selection method.

Chapter 6 – Detail Design

This chapter consists of the detail drawing of the product.

Chapter 7 – Result & Discussion

This chapter discussed in details the results from the DFA and DFM analysis done manually and the outcomes of this project.

Chapter 8 – Conclusion

This chapter will conclude all the results and findings that have been completed.

1.7 Conclusion Remarks

In this chapter, the author reviews about the objectives, problem statements and scopes of this project. The author also reviews the outline of this report in general which consists of 8 chapters including this chapter. The background and history of the lazy chair are also discussed in this chapter generally as the details will be further discussed in the next chapter.

CHAPTER 2

LITERATURE REVIEW

This chapter will discuss further on the project. The first subject to be discussed is modular product. The topics covered are the definitions and advantages of modularity. This chapter also will discuss about the Do It Yourself assembly method, Design for Manufacture and Assembly and about the chair itself.

2.1 Modular Product

A product can be thought of in functional and physical terms (Ulrich and Eppiger 1995). The physical elements of a product are the parts, components and subassemblies. The physical elements may be presented into several major building blocks and each of the blocks implement some functions of the product. The block also called as the module. Modularity is an important aspect in product architecture. As an example, the figure below shows the design of a drawer. **Figure 2.1(a)** shows that the drawer and the open space are allocated to separate modules. It shows the design of modular architecture and each module may be designed independently. **Figure 2.1(b)** shows the traditional architecture design which is more complicated and the blocks are not designed independently.

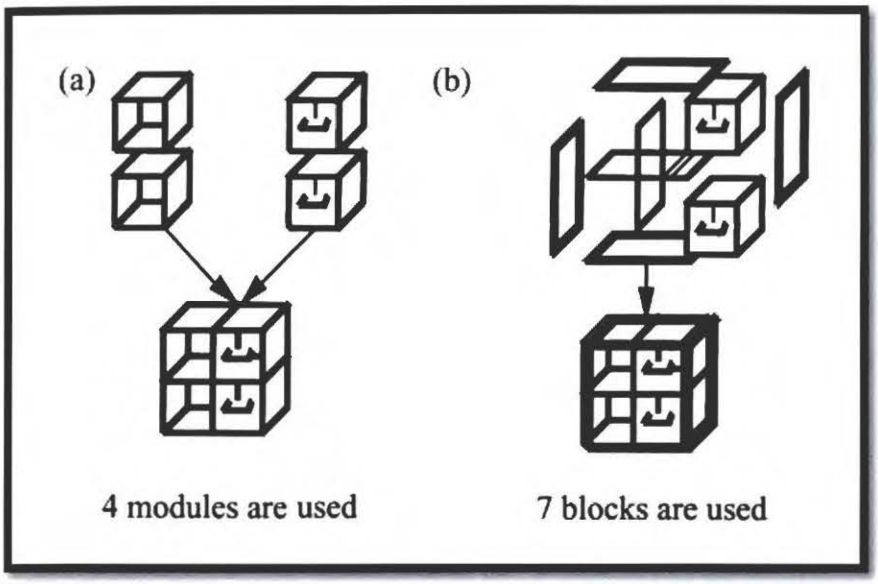

Figure 2.1: Designs of a drawer (Huang 2000)

2.1.1 Definitions

Modularity is a common but unexplored thread among all areas of life-cycle engineering. It has become very famous in studies recent years though it has existed for at least 30 years. Modular products tend to have fewer components for assembly and therefore cheaper to assemble. Modularity has no specific definitions and in fact according to (Gershenson 2003), *there is no agreement on the definition of modularity*. Modular product can be defined in many ways and shown below in **Table 2.1** are some examples of the definitions:

Table 2. 1: Definitions of Modular Product

Authors	Definitions
Pahl and Beitz	*Modular products* refer to products, assemblies and components that fulfill various functions through the combination of distinct building blocks (Pahl 1988)
Ulrich and Tung	Define modularity in terms of two characteristics of product design (Ulrich

	1991): 1. Similarity between the physical and functional architecture of the design. 2. Minimization of incidental interactions between physical components.
Erixson and Kusiak	Define modularity as a tool to decrease assembly and manufacturing costs in product families and manufacturing systems (Erixson 1996).
Chun Che Huang	The terms *modularity* in products is used to describe the use of common units to create product variants (Huang 2000).

In general, modular product is an assembly with reduced parts, less complicated and easy to assemble. Due to the functional independence it creates, modularization has been called the goal of good design (John K. Gershenson 1999).

2.1.2 Advantages of Modular Product

Modularity has a lot of advantages and benefits, as an example, modularity allow the designer to control the degree to which changes in processes or requirements affect the product. According to Ulrich and Tung (Ulrich 1991), they described the benefits of modularity as:

1. Greater product variety. A modular product design can be partitioned technically and variations in functional components can be substitutes into modular architecture to create product variations based on different combinations (Eggen 2003).
2. Economies of scale. Since each module will usually be produced in a batch of large scale, natural economies of scale arise.

3. Ease of product updating. A modular product is decomposed into modules; only certain modules need to be replaced. And for same reason, upgrades, updates, maintenance and disposal are simpler.
4. Increased product variety. The use of modules means that a great product variety can be achieved using different combination of modules.
5. Reduced order lead-time. Since modules are manufactured in relatively large scale, the production can be organized so as to reduce manufacturing lead time.
6. Ease of design and testing. As the component is produced in modules, the design is simple and for testing purpose, the components can be tested individually.

Designing a modular product can gives the result of product cost and development time higher or lower. If the designs are simple needs simpler manufacturing process, the cost can be low but if the designs are complicated and needs a lot interfaces between the modules, the cost may be higher. The development time is often lower once the design is split into modules, where the design teams can work in parallel on the different modules.

2.1.3 Modular Architectures

There are two types of product architecture; modular architecture and integral architecture. An integral architecture includes a complex mapping from functional elements to physical components (John K. Gershenson 1997). In the other hand, modular architecture has a one-to-one mapping. Modular architecture allows a design change to be made to one module without requiring a change to other modules for the product function properly (Eggen 2003).

Typical examples for modular architecture which is close to one to one mapping between functions are mechanical pencil, personal desktop computer and pocket knife. The examples shown in **Figure 2.2** below.

Figure 2.2: Examples of Modular Product (Hölttä-Otto 2005)

In the other hand, typical examples of integral architecture where it is hard to determine what part of a product performs which function are an old fashioned pencil, a laptop and a hunting knife. The examples shown in **Figure 2.3** below.

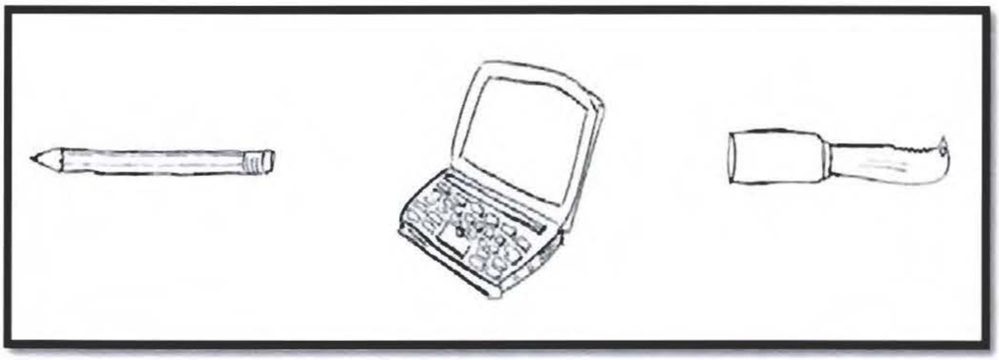

Figure 2.3: Examples of Integral Product (Hölttä-Otto 2005)