

NEW CONCEPT OF FURNITURE DESIGN BY USING SPACE SAVING
APPROACH

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ABSTRACT

Many people have to live in small spaces, especially in the big cities like Kuala Lumpur. In current market, there are available a lot of space saving furniture suitable be use to help people for saving living space. Sofa bed also one of the space saving furniture. The objective of this project to design a new concept of sofa bed by using space saving approach with the apartment living concept. The sofa bed will be design which it has more than three or more function. Furthermore, literature studies on the sofa bed for current market and some online sources like patent. This report is follow the design process flow start from identify the problem, recognize the need, engineering design specification, conceptual design, select the best design, configuration design, parametric design and detail design . The report included house of quality because is a systematic graphic representation of product design information. All the product design will use the morphological chart as guidelines to design a new concept of sofa bed. Five concept designs for sofa bed with brief description will be in this report. The method to use for select the best concept design among the five concept design is “weighted rating method”. The highest weight rating of design concept will continue the future development in this project. All the part of sofa bed is draw by using SolidWorks. After that, some of the sofa bed part to be used for FEM analysis obtains some useful information. Besides that, the manual calculation will compare with the FEM analysis result. Finally, all the sofa bed part will convert into detail drawing and attach it in this report.

ABSTRAK

Ramai orang terpaksa bertinggal dalam ruang-ruang yang kecil terutama sekali dalam bandar raya besar seperti Kuala Lumpur. Dalam pasaran sekarang, ia terdapat banyak perabot yang menjimatkan ruang amat sesuai digunakan untuk membantu orang dalam tempat tinggal mereka. Katil sofa juga salah satu daripada perabot yang boleh menjimatkan ruang. Projek objektif ini adalah mereka satu konsep yang baru katil sofa dengan menggunakan ruang dengan konsep kehidupan di pangsapuri. Katil sofa direka di mana ia mempunyai tiga atau lebih banyak fungsi. Seterusnya, kajian ilmiah dibuat pada katil sofa dalam pasaran semasa dan sumber-sumber dalam internet seperti paten. Laporan ini adalah mengikut pengaliran rekabentuk proses bermula dari mengenal pasti masalah, mengenali keperluan, spesifikasi rekabentuk kejuruteraan, rekabentuk konseptual, memilih rekabentuk yang terbaik, rekabentuk tatarajah, reka bentuk parameter dan rekabentuk terperinci. Laporan ini juga mengandungi rumah kualiti kerana ia ialah satu gambaran grafik sistematik maklumat untuk reka bentuk produk. Semua rekabentuk produk akan menggunakan Carta Mofologikal sebagai garis panduan untuk mereka konsep baru untuk katil sofa. Lima konsep rekabentuk untuk katil sofa dengan penerangan yang umum akan terkadung dalam laporan ini. Kaedah “Weighted Rating Method” digunakan untuk memilih rekabentuk konsep yang terbaik. Konsep rekabentuk mempunyai markah yang tertinggi akan dipilih untuk meneruskan penyelidikan dalam projek ini. Semua bahagian untuk katil sofa adalah melukis dengan menggunakan SolidWorks. Setelah itu, beberapa bahagian dari katil sofa akan digunakan untuk menjalankan FEM analisis untuk mendapatkan beberapa maklumat yang berguna. Selain itu, pengiraan manual akan dibandingkan dengan hasil FEM analisis. Akhirnya, semua bahagian sofa bed akan menukarkan ke dalam lukisan yang teliti akan terkadung di dalam laporan ini.

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CHAPTER I

INTRODUCTION

1.1 Background

For centuries, furniture is made for the same purposes. Desks, tables and workbenches provide space for work and dining. Chests, cabinets and cases are built for storage. Sofas, chairs, beds and benches are made for resting. Today we have furniture for every imaginable situation from a baby's high chair to steel office desk. They range from soft, pillow-like upholstered sofas to sleek tables of metal and glass.

Furniture is built to make people's live easier and more comfortable. The furniture industry divides them into various board groups. One way of grouping furniture is according to where and how it used. Furniture that is used at home makes up another large group and can be classified by its style.

In today Malaysia home furnishing products, there are available many type of space saving furniture like table and chair can be fold using wide in the market. Sofa bed is one of the spaces saving furniture. Sofa bed is a piece of furniture which it can be used as both a sofa and a bed. This wonderful flexibility of sofas convertible into beds have proved of great help those who live in small apartment and worried about the accommodation of extra guest for sleep over. They can easily be converted into beds at nights and after its purpose served it can be rearranged back to sofa. They are not difficult to be arranged and rearranged as they are flexible and comfortable enough to handle.

1.2 Problem Statement

Smaller homes with smaller lots are becoming more and more common in the Malaysia. This is hardly surprising considering how expensive real estate can be. Space is at a premium even more so in the city. Plenty of people work and live near or even alongside business in small apartment. Because of that, we should be clever in choosing the right and ideal furniture.

Many people dealing with limited area to force them to more creative to make a small apartment become a comfortable living space. The apartment was divided to the bedroom, bathroom, kitchen and living room. These will make we feel lack out of space for our house. We have to try eliminating some unnecessary furniture and finding right one would make our house or apartment look more spacious. So, we have to choosing functional and practical furniture can be very useful to maximize the space area. Many people prefer the furniture can use in multifunction and space saving in their house. This will let the people save the money and use the furniture with multipurpose according to their needs.

Most people sometime will need some extra bed to accommodate a guest but they do not have enough space in their house to have extra mattress bed. They just cannot afford to space that to used one in a while.

1.3 Objective

This project is to design a new concept of sofa bed by using space saving approach with the apartment living concept.

1.4 Scope

- 1) Conduct literature study on the related area
- 2) Design a sofa bed that have 3 or more function
- 3) Design it mechanism system to make it user friendly

CHAPTER II

LITERATURE STUDY

2.1 Sofa Bed Type

i) Fold-out sofa bed

According to Barabas (1973), the fold-out sofa bed is a type which it has the longest dimension of the mattress extends parallel to back of sofa bed. According to Stevens (1986) , it include a foldable sofa bed mechanism having pivotally interconnected head, body , intermediate and foot frame section which is adapted to mount on a stationary sofa sections. It has a spring loaded opening mechanism which it usually pulls out from center of the sofa frame. The bed base is supported by a pair of legs. But there is a drawback with this which its strength longevity and too many moving part.



Figure 2.1: Fold out sofa bed

(Source: <http://www.alecs3piecesuites.co.uk/sofabed.php>)

ii) **Flip-over sofa bed**

This type of sofa bed simply unfolds directly onto the floor, so that the solid foam seat becomes the sleeping area. Some models lie all the way on the floor so that even the back of the sofa becomes part of the bed. Flip-over sofa beds are easy to operate and make an ideal place for adult and kid to sleep. The disadvantage is some of models are eating the living space when the sofa is unfolded. (<http://hubpages.com/hub/Sofa-Beds-and-Futons>)



Figure 2.2: Flip-over sofa bed

(Source: <http://www.elbectoykingdom.co.uk/product.php?xProd=733>)

iii) **A-Frame Sofa Bed**

The seat and the back on the A-frame sofa form the bed either single or double. According to Rogers (1974), a sofa bed including a seat frame and backrest frame including a seat mattress mounted on the seat frame and backrest mattress mounted on the back rest frame. According to Fireman (1991), it converting from a sitting position to horizontal position and providing proper support against overbalancing. One of the main advantages of the A-frame sofas is that some of them comes with an underneath storage area where the beddings and covers can stored of the day. The disadvantage is the physical efforts are required to move a sofa when we want to used sofa bed.



Figure 2.3: A-frame sofa bed

(Source: <http://www.broadwayfuton.com/broadway/scripts/prodView.asp? Idproduct=246>)

iv) **Drop End Sofa Bed**

The drop-end sofa bed can be an ideal solution for small apartment because it is easy to use and save space. With the flip of couple of levers, we can fold the arms or ends of sofa down to create a large chaise lounge. We also can further manipulate to create a single or small double bed. (<http://hubpages.com/hub/Sofa-Beds-and-Futons>)



Figure 2.4: Drop end sofa bed

(Source: <http://www.apartmenttherapy.com/ny/seating-sofas-armchairs/manstad-sofa-bed-with-storage-from-ikea-045592>)

2.2 Sofa Bed Mattress

In current market, there are no every sofa bed is same dimensions. Most of them have more than one set of bed mattress dimensions available. The most common size is:-

- i) Single : 24" x 72"
- ii) Twin: 38" x 72" or 35" x 72"
- iii) Queen: 60" x 72" or 60" x 80"(not as common)

The depths for sofa bed mattresses range between 3.5 – 5.5 inches with average being 4.5".

2.2.1 Type of Sofa Bed Mattress

Currently, there have five most common types are used to make sofa bed mattress which are latex, memory foam, air, urethane and innerspring.

i) Latex sofa bed mattress

This type of sofa bed mattress tends to be the most comfortable and by far the most durable but also the most expensive. This is because the process involved to manufacture them is quite costly and rubber trees are very hard to come from Sri Lanka or Southeast Asia. Latex is naturally hypo-allergenic, dust mite resistant, eco-friendly and they return to their original shape with no delay time. Latex mattress tend to expensive less sagging , rutting and ditching when compared to other products. Latex mattresses provide precise support for the whole body and distribute pressure in a very good way. Latex provides a stable sleeping comfort and absorbs the shock of body movements and ensures end user get a restful and uninterrupted sleep. (Source: IKEA brochure)

ii) Memory foam sofa bed mattress

The memory foam responds to individual body temperature and eliminates motion transfer between sleeping partners. This type of

mattress is among the best for pressure point relief. Memory mattresses give firm support, stable sleeping comfort and absorb the shock of body movement. Memory foam sofa bed mattresses respond based on end user body temperature so it's important to get one that uses open cell memory foam. (Source: IKEA brochure)

iii) Air over coils sofa bed mattress

The air over coil sofa bed mattress is similar to sleep number bed but with coils. This type of mattress can changing air into mattress will adjust the firmness. The advantage for air mattress is able to adjust how the mattress feels and having a higher profile mattress (air mattresses can expand to 11"). The disadvantages are high cost, having to reinflate because of leakage, having to deflate the mattress before end user can fold it into the couch each night and costly replacement parts .(<http://www.sofabedmattress.org/>)

iv) Urethane foam sofa bed mattress

The urethane foam sofa bed mattress also called the Poly-urethane Foam. Poly-urethane has become highly popular and is gaining a wider acceptance among users. According to Dell' Accio (2008), one particular class of mattress utilizes an upper layer of poly-urethane memory foam. However, the poly-urethane foam is only suitable for the upper portion of the cushion or mattress as it does not provide sufficient support.

v) Coil sofa bed mattress

According to Hartline (1996) ,the industry has moved away the thin mattresses to thicker mattresses to more approximate the size and comfort characteristics of fixed bed mattresses , which it has ability to fold and compress the thicker mattress. This makes the coil sofa bed mattresses have a reputation for being the least comfortable of the sofa mattress types. That's because the average coil sofa bed mattresses has only a 1/2 inch of padding on top of a 3" steel coil. Regular mattresses are usually pretty thick and can accommodate a

coil high enough to float before it's fully compressed. It's impossible to fit a high profile coil into a sofa mattress. Another issue is hydrogen embrittlement during the coil manufacturing process. When the coils go through electroplating, the hydrogen that's absorbed in carbon steel causes the coil to become brittle. This can lead to stressing, cracking, and failure. (Source: <http://www.sofabedmattress.org/>)

2.3 Sofa Bed Frame

According to Kessler (1995), a sofa bed which has a base with seat member, a back member and a bed member. The sofa bed has linkage which connects the seat and the back and bed members together. The frame for sofa bed usually is made of wood or steel. The metal frame is most expensive because it is more hardness and stronger compare with wood. For maximum durability, the sofa frame should be constructed from hardwood using screws and glue than staples or nails. The sofa bed should avoid constructed from soft woods or particle board. The hinges, springs and other inner mechanisms should be rounded or smooth to avoid ripping the fabric of the sofa or sheets on the sofa mattress. (<http://www.sofabedmattress.org/>)

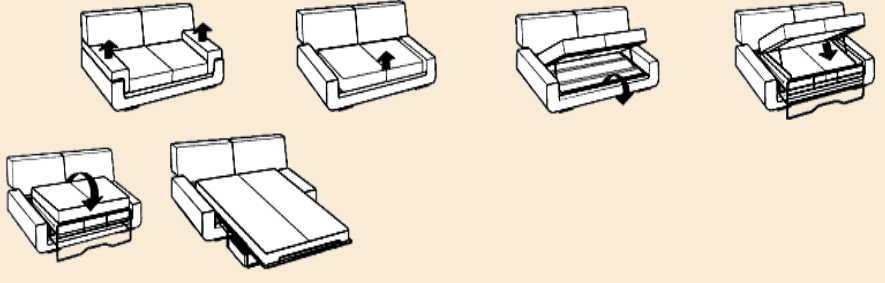
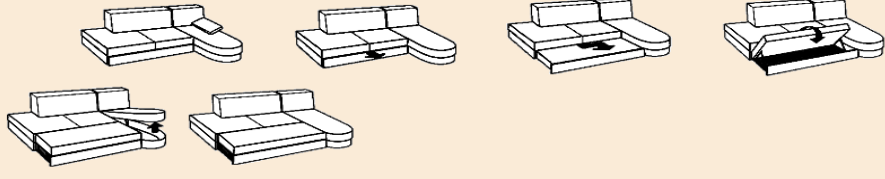
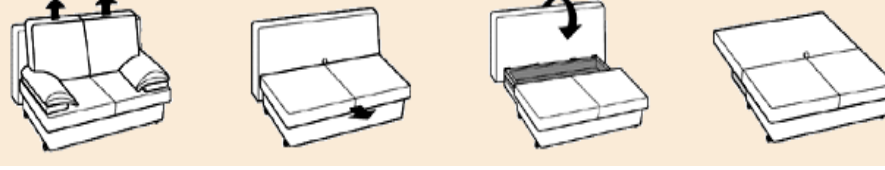
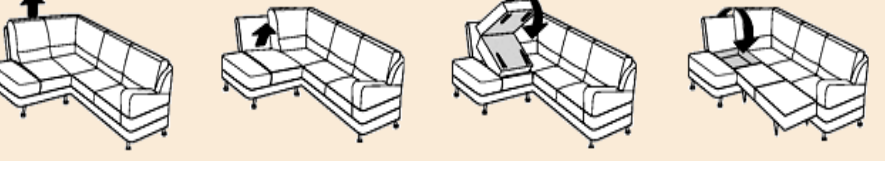
2.4 Sofa Bed Mechanisms


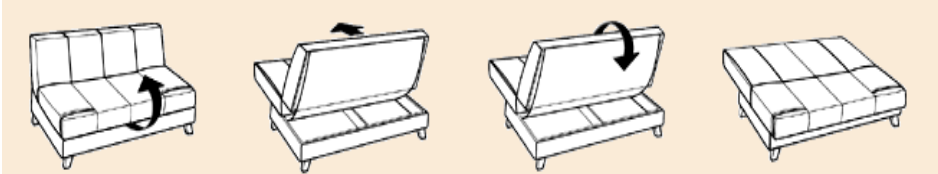
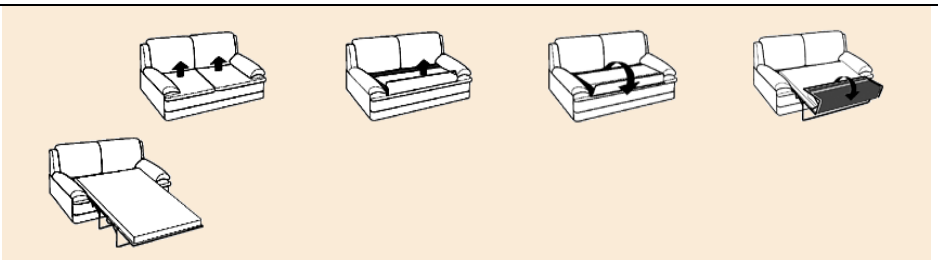
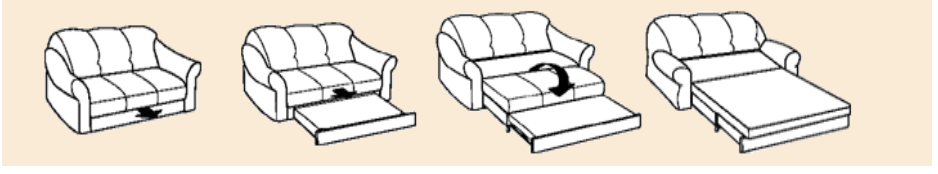
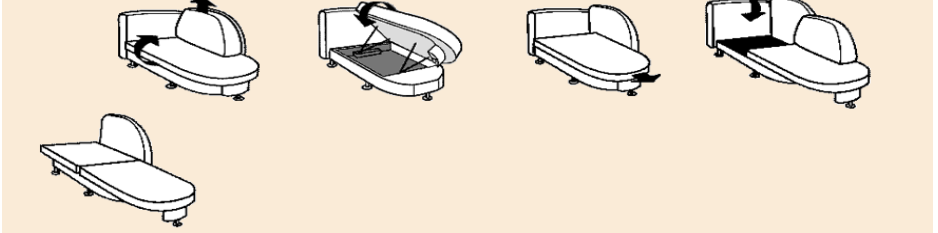
The variety type of mechanisms sofa allow satisfying to most exacting taste and increasing functionality of any sofa. On a way of transformation all mechanism can be divided into three basic types conditionally:-

- i. Traditional – allowing to put forward half sitting and to throw backs.
- ii. Book – under sitting is the mechanism which is displayed in a berth.
- iii. The folding mechanism –from under sitting the berth, type “sofa” is put forward or rolled out.

In current market, the mechanism of transformation such as “book” is cheaper than other mechanisms but it is usually used less than in 20% of production. The principle mechanism is maximum simple which are we lift sitting before click and we lower the sofa is spread out. If the sofa stood in the middle of a room or even in twenty centimeters from a wall, all is taken place. The mechanism significant physical efforts are required to move a sofa. The Table 2.1 shows the various type of sofa bed mechanism transformation.

Table 2.1: The various type of sofa bed mechanism transformation

No.	Type of sofa bed mechanism transformation	Description
1		The American folding bed
2		Dolphin
3		Euro the book
4		Cascade

5		Clik - cljak
6		Book
7		The French folding bed
8		Sofa
9		Sofa – D

(Source:<http://www.nirgos.com/mechanisms-transformation-furniture.html>)

2.5 Computer Aided Design

Computer Aided Design (CAD) is used wide range of computer based tools that help engineers, architects and other design expert in their design works. The modern CAD packages can also frequently allow rotations in three dimensions and allowing viewing of a designed object from any desire angle, even from the inside looking out.

CAD is used in the design of tools and machinery and in the drafting and design of all types of buildings from small residential types to largest commercial and industrial structures.

CAD is mainly used for detailed engineering of 3D models and 2D drawings of physical components, but it is also used throughout the engineering process from conceptual design and layout of products, through strength and dynamic analysis of assemblies to definition of manufacturing methods of components.

(Source: http://www.apparesearch.com/definitions/miscellaneous/cad_computer_aided_design.htm)

2.5.1 SolidWorks

The SolidWorks will use for analysis and simulations for the entire frame for sofa bed. SolidWorks is a 3 Dimensional mechanical CAD (computer aided design) was developed by Dassault Systems SolidWorks Corp. Dassault Systems SolidWorks Corp. offers complete 3D software tools that let engineer to create, simulate, publish, and manage the data. SolidWorks are easy to learn and use by all people to design the products better, faster and more cost-effectively. At SolidWorks, it dedicated to providing all the engineers, designers and other creative professionals in any industry meet the demand for innovative and high quality products in less time and at lower cost. SolidWorks has ranked as the 3D technology experience that employers seek most in job posting in Moster.com, the most popular employment website.

(Source: http://www.solidworks.com/sw/183_ENU_HTML.htm)

2.5.2 History

Before SolidWorks start to recommend to public, the all the industry was starved for software that combined 3D solid modeling with ease of use in desktop or laptop.

The SolidWorks95 start introduce in 1995 as a competitor to CAD programs such as Pro/ENGINEER, Unigraphics. SolidWorks was founded in 1993 by Jon Hirschthick who recruited a team of engineers to build a company

that developed 3D CAD software that easy for use , afford and available on the desktop with its headquarters at Concord, Massachusetts , USA and released its first product. Within two months, SolidWorks was winning accolades for ease of use and allowing more engineer and designer use for design their product in any industry.

At the present time, DS SolidWorks offers a complete toolset to create, simulate, publish, manage data, maximizing the innovation and productivity of engineering resources. This allows organizations to design the product better, faster and more cost effectively.

(Source: http://www.solidworks.com/sw/656_ENU_HTML.htm)

2.5.3 SolidWorks Modeling Methodology

The SolidWorks is a great solid modeler to create the model and assemblies in any design project.

Parameters are referring to the shape or geometry of the model or assembly. Parameters can be numeric parameters such as circle diameter or line length or geometric parameters such as parallel or concentric, etc. The numeric parameters can be associated with each other through the use of relations which allow them to capture design intent.

Design intent is the way creator of the part wants it to respond to changes and updates. For example, we can the hole at top of the cup can stay at top surface regardless of the height or size of the cup. The SolidWorks allows us to specify that hole on the top surface and no matter what the height us later gave to the cup.

Features refer to the blocks of the part. Shape based features begin with a 2D or 3D sketch of shapes such as holes, slots, etc. This type of shape will extrude or cut to add or remove material from the part. The operation based features are not sketch based include features such chamfer, shells, fillets, applying draft to faces of a part, etc.