



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**FINITE ELEMENT ANALYSIS OF TRAY COVER DESIGN FOR
DIGITAL VERSETAIL DISC PLAYER**

This report submitted in accordance with requirement of the Universiti Teknikal
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(Maintenance Technology) (Hons.)

by

MOHD SYAFIQ SYIMIR BIN MOHAMAD

B071210076

871117035439

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Type your department's name here) (Hons.). The member of the supervisory is as follow:

.....
(Mr. Azrin Bin Ahmad)

ABSTRACT

Digital video disc is commonly known as Digital versetail disc. DVD is an electronic device that used to read data, music and audio visual. During installation and assembly process, there are few problems have been detected, such as broken tray cover. Tray cover is a plastic part in (DVD) named as Tray Cover. Hook is one of the parts of tray cover that always broken due to the loads applied by the operator which are not suitable for the assembly process. During the assembly process, the hook fails at 30N. A tray cover which is a part that is snap-fitted with the disc tray section of a Digital Versatile Disc (DVD) Player will be analyzed using Linear Static Analysis. The purpose of this study is to analyze and redesign the tray cover hook of a DVD player. The design of the tray cover is using snap-fit. The 3D modelled has been analyzed by using Finite Element Analysis (FEA) in Catia V5 software. The weakness of the current design will be improvised by redesign process. The mesh convergence test was done to define the optimum element size of whole part of the model. Stress analysis has been done based on the size element gained from the convergent test. Stress analysis done starts from 10N to 53N and until the von mises shows that it reached the yield strenght fail which is 68.4MPa. The result of stress analysis done obtained was fail at 56N. Then, analysis is being continued by adjustig the hook shape thickness. The hook thickness was being modified from 0.57mm to 1.4mm that has been tested where 1.1mm thickness size is the best where it can withstand 59.8N load. Next is the implementation of shape optimization for the hook where 0.5mm was added to the sharp corner and 3mm radius at the support rib and this optimization gain the best result where it withstand 63N of load.

ABSTRAK

Cakera video digital dikenali sebagai cakera Digital Versetail. DVD adalah peranti elektronik yang digunakan untuk membaca data, muzik dan audio visual. Semasa proses pemasangan, terdapat beberapa masalah yang telah dikesan seperti dulang penutup patah. Dulang penutup adalah satu component plastik pada (DVD) yang dinamakan sebagai “Tray Cover”. Cangkuk adalah salah satu bahagian perlindungan dulang yang sentiasa patah akibat beban yang dikenakan tidak sesuai oleh pengendali dalam proses pemasangan. Semasa proses pemasangan, cangkuk itu gagal pada 30N. Satu dulang penutup yang merupakan bahagian yang dipasang secara sentap dengan bahagian dulang cakera. Pemain cakera Versatil Digital (DVD) akan dianalisis menggunakan Analisa Statik lurus. Tujuan kajian ini adalah untuk menganalisis dan mereka bentuk semula cangkuk dulang penutup pemain DVD. Reka bentuk dulang penutup menggunakan pemasangan secara sentap. 3D dimodelkan telah dianalisis dengan menggunakan analisis unsur terhingga (FEA) dalam perisian Catia V5. Kelemahan reka bentuk semasa akan diubahsuai oleh proses reka bentuk semula. Ujian penumpuan jejaring telah dilakukan untuk menentukan saiz elemen optimum seluruh bahagian model. Analisis tekanan yang telah dilakukan berdasarkan elemen saiz yang diperolehi daripada ujian tumpuan jejaring. Analisis tekanan dilakukan bermula dari 10N sehingga 53N dan Von Mises menunjukkan bahawa ia telah mencapai hasil kekuatan gagal yang 68.4MPa. Hasil analisis tekanan dilakukan diperolehi ialah gagal pada 56N. Kemudian, analisis sedang diteruskan dengan mengubahsuai ketebalan bentuk cangkuk itu. Ketebalan cangkuk telah diubahsuai dari 0.57mm kepada 1.4mm dan telah diuji di mana saiz ketebalan 1.1mm adalah yang terbaik di mana ia boleh menahan beban sebanyak 59.8N. Seterusnya ialah pelaksanaan pengoptimuman bentuk untuk cangkuk di mana menambah serongan 0.5 mm di penjuru tajam dan jejari 3 mm di rusuk sokongan dimana pengoptimuman ini mendapatkan hasil yang terbaik di mana ia mampu menahan beban sebanyak 63N.

DEDICATIONS

I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice through my life. I am really thankful for their sacrifice, patience, and understanding that were inevitable to make this work possible. Their sacrifice had inspired me from the day I learned how to read and write until what I have become now. I cannot find the appropriate words that could properly my dreams. Lastly, I would like to thank any person which contributes to my final year project directly or indirectly. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this study.

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LIST OF SYMBOLS AND ABBREVIATIONS

2D	-	Two Dimensional
3D	-	Three Dimension
CAD	-	Computer Aided Design
CD	-	Compact Disc
CAE	-	Computer Aided engineering
CATIA	-	Computer aided Tree Dimension
CFD	-	Computational Fluid Dynamics
CAM	-	Computer Aided Manufacturing
DVD	-	Digital Versatile Disc
FEA	-	Finite Element Analysis
FEM	-	Finite Element Method
K, k	-	Stiffness Matrix, Structure (Global) and Element, respectively
Kj	-	Kilo Joule
MBD	-	Multi Body Dynamic
Mpa	-	Mpa
Mm	-	Millimetre
PP	-	Polypropylene
Pa	-	Pascal
P	-	Pressure
PCL/TPS	-	Polycaprolactone/Thermoplastic Starch Blend
R	-	Vector of Nodal Loads Applied to a Structure
SAN	-	Styrene Acrylonitrile
E	-	Elastic Modulus
>	-	More than
σ	-	Stress
ϵ	-	Strain
τ	-	Torque

CHAPTER 1

INTRODUCTION

1.1 Introduction

Digital versatile disc (DVD) player is a device used widely in the world; almost every house has a DVD player. In the entertainment world, DVD player is mainly used to play media program, such as movies and music. The main components in DVD player consist of plastic parts, metal parts, optical drive and others. The snap fit is a one concept that where the one component is fitted to each other without using screws or rivet. The cover tray or tray cover is designed by using snap fit method. The cover tray is a plastic part that pressed between cover tray and disc tray together such as clips. The purpose of snap fit design is for easier assembly process. The hooks are developed to lock the tray from movement of tray disc.



Figure 1.1: Tray cover of a DVD player. (DVD-players.toptenreviews.com)

Finite Element Analysis is one of the analysis methods used to analyze parts in industrial design. This analysis method is one of the suitable methods for product development success. The analyze product can be simulate in software to produce the suitable result to make the prototype. Finite element analysis method is one of the best methods compare to conventional methods. The conventional method is one of the oldest methods that use a lot of prototype testing for analysis before a product can be produced. Due to the variation of the prototype model to be produced and analyzed, it will consume more time and increase the downtime. Figure below shows the different of graph between traditional methods of design and CAD in terms of cost, time taken to manufacture and profits.

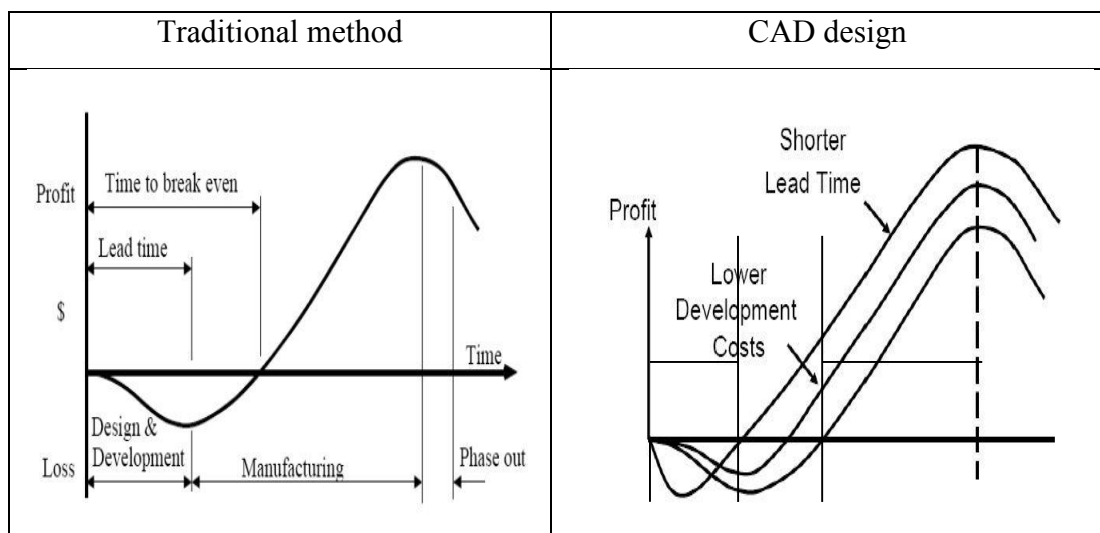


Figure 1.2: The different of graph between traditional methods of design and CAD. (Mohammed, May and Alavi, 2008).

Computer aided design technology especially (CAD/CAE/CAM) provides a wide variety of design and analysis which more efficient and able to provide detailed solutions in product design and development. This study about the analysis on the design of the cover tray using CATIA software and Finite Element Analysis techniques. This study will use CATIA software to redesign the cover tray and performing Finite Element Analysis. The result obtained from the design analysis is then made into prototype using rapid prototype machine. The analysis covers the contents of materials, physical constraints and also the characteristics of the design.

1.2 Problem Statement

During installation and assembly process there are few problems such as broken tray cover. The tray cover hook broken due to the applied loads that are not suitable for operator assembly. In the production line in the industry, the hook usually breaks at 30N load is applied onto the tray cover and disc tray. This will affect the production of disc player. The decrease of the production will occur due to the delay in the production. Due to this problem, the cost of the production will increase thus lowering the production rate. In addition, the product may affect customer satisfaction when released in the market. Improvements should be made in term of design to avoid the same failure. Few variations of the design must be made and tested using Finite Element Analysis technique. The process of finite element analysis should be performed by researching of product material, geometry CAD, selecting the load area, and meshing process. Before starting the redesigning process, the tray cover needs to be analyzed so that defect can be study on the original parts before any improvement can be made on.

1.3 Objectives

From the problem statements that have been stated, the objectives of this study are.

- i. To redraw the hook of cover tray for the digital versatile disc player using CAD software.
- ii. To generate a CAD model to confirm that the design is proper and suitable.
- iii. To do an improvement on the hook of the cover tray in term of design.
- iv. To analyze the CAD model by using Finite Element Analysis.

1.4 Scope

To achieve the objective of the research study, several work scope have been identified:

- i. Study and identify the problem from the previous design with its characteristic on material properties and physical constrain.
- ii. Generating the CAD model to confirm that the design is proper and suitable using CATIA software.
- iii. Improvising the design of the hook of cover tray.
- iv. Analyzing the new design of the cover tray hook by using finite element analysis testing with CATIA software.

CHAPTER 2

LITERATURE REVIEW

2.1 DVD Player

Digital video disc or digital versatile disc, (DVD) is an electronic device to read data, music, and audio visual. DVD player consists of three categories such as DVD-ROM, DVD Audio, and DVD Video. DVD-ROM is upgraded model of CD-ROM. It has large capacity storage from CD-ROM and has high processing rate of information. (Musgrave, 2001). Digital video disc (DVD) player is a device that is used widely in the world. It is used in every nook of corner in this day and age. The DVD player is not a luxury device nowadays because it can be found in every house nowadays. The DVD player is known for entertainment purposes such as watching movies. Besides that, DVD player can also be used in learning program where learning session can be made by playing education videos such as documentary program. There are two main materials used to make DVD player which is metal and plastic.

2.2 Metal Part

Metal part is important in industries of manufacturing of product. Metals used in the electronic products are, usually consist in small parts, component, and other combined part. Metals consist of two categories which are ferrous metal and nonferrous metal. Nonferrous metal does not only contain relatively small amount of iron, there are also other element such as aluminum, copper, zinc, and nickel. The nonferrous metal is widely used in electronic device component because it is easy to fabricate and light weight. (F.Smith, 2011)

2.3 Plastic Part

Nowadays, plastics are widely used in most equipment. This is because of its lightweight and easy to fabricate. Plastic is a type of polymer that has large molecules consist of long repeating chains of smaller molecular known as monomers. Plastic is mainly used in industries such as electronic device, packaging, automotive manufacture, house appliance and others. Plastic can easily adapt with other material such as metal, wood, and glass. This combination of plastic is called joint part. The advantage of molding is that separate plastic parts is previously combined the parts to several parts into one part including functional components. However, due to the limitations of the mold and the process, functional requirements, and economic considerations, it is still sometimes necessary to mold various components separately and then assembled them together. (Mills, 2005).

2.3.1 Thermosetting

Thermosetting plastic is a permanent plastic shape when it formed. Thermosetting cannot be melted and remolded into another shape, but decompose upon being heated to too high a temperature. The solidification process of plastics is known as preservation process. The transformations from the liquid state to the solid state are irreversible process, which involves the heat and chemical reaction of the process to form the bonded molecular structure. Thermoset cannot be recycled to a new part. During curing process, the small molecules are chemically linked together to form complex interconnected network structures. This cross linking prevents the slippage of individual chains. Therefore, the mechanical properties, tensile strength, compressive strength, and hardness are not temperature dependent. Hence, thermosets are generally stronger than the thermoplastics. There are few common types of Thermoplastic such as Alkyds, Allylics, Amine, Bakelite, Epoxy, Phenolic (PF), Polyester, Silicone, Polyurethane (PUR), and Vinyl Ester. Thermosets are commonly used for high temperature applications. Some of the common products that used thermoset are electrical equipment's, motor brush holders, printed circuit boards, circuit breakers, kitchen utensils, handles, and knobs. (F.Smith, 2011).

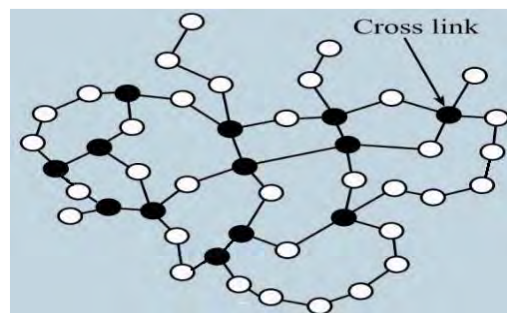


Figure 2.1: Molecular structure of Thermoset (online note, 2015).