UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN OPTIMIZATION OF FRYER BASKET USING FINITE ELEMENT ANALYSIS

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) with Honours

by

SALWA BINTI ISMAIL
B051210138
911114-02-5116

FACULTY OF MANUFACTURING ENGINEERING
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TAJUK: **Design Optimization of Fryer Basket using Finite Element Analysis**

SESI PENGAJIAN: **2014/15 Semester 2**

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ABSTRACT

In manufacturing industry, design is very important. Any product to be produced must going through the design stage which it consists of identification of customer need, concept idea, concept selection such as screening and scoring and others. After the concept idea for the product is selected, CAD software is used to create the model. The model not only has aesthetic value, but the design also can be used for simulation. This projects is about the study of design optimization by using finite element analysis. The product is the fryer basket that used for food industry. This project consists of the design process, redesign and improvement process to obtain better analysis value of stress, displacement, mass and volume. The optimization happened in the redesign process. This project is driven by three main objectives that are to study the design of existing fryer basket, to optimize fryer basket design using Finite Element Analysis (FEA) and lastly to suggest the best analysis and design of fryer basket.

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ABSTRAK

Dalam industri pembuatan, reka bentuk adalah sangat penting. Mana-mana produk yang akan dihasilkan haruslah melalui peringkat reka bentuk di mana ia mempunyai beberapa kriteria iaitu mengenal pasti keperluan pelanggan, idea konsep, pemilihan konsep seperti pemeriksaan dan pemarkahan dan lain-lain. Selepas konsep untuk produk dipilih, perisian CAD digunakan untuk menghasilkan model. Model ini bukan sahaja perlu mempunyai nilai estetik, tetapi ianya juga haruslah boleh digunakan untuk simulasi. Projek ini adalah mengenai kajian pengoptimuman reka bentuk dengan menggunakan analisis unsur terhingga. Produk yang dikaji ialah bakul penggoreng yang digunakan untuk industri makanan. Projek ini terdiri daripada proses reka bentuk, mereka bentuk semula dan proses peningkatan untuk mendapatkan analisis nilai yang lebih baik daripada tekanan, sesaran, jisim dan isi padu. Pengoptimuman reka bentuk berlaku dalam proses reka bentuk semula. Projek ini dipacu oleh tiga objektif utama iaitu untuk mengkaji reka bentuk bakul penggoreng yang sedia ada, untuk mengoptimumkan reka bentuk bakul penggoreng menggunakan Finite Element Analysis (FEA) dan akhir sekali untuk mencadangkan analisis dan reka bentuk terbaik untuk bakul penggoreng.

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DEDICATION

All this hard work is dedicated to my beloved parents,

Ismail bin Hashim and Norma binti Mat Isa.

Not to forget my younger brothers Akiff, Aiman and Azril.

Lastly, to my supervisor, lecturers and friends for their help and endless support.

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LIST OF ABBREVIATIOS

2D	-	Two dimensional
3D	-	Three dimensional
AISI	-	American Iron and Steel Institute
ASTM	-	American Society for Testing and Materials
CAD	-	Computer Aided Design
CADD	-	Computer Aided Design and Drafting
CAE	-	Computer Aided Engineering
CAGD	-	Computer Aided Geometric Design
FEA	-	Finite Element Analysis
FOS	-	Factor of Safety
FOS	-	Factor of Safety
HOQ	-	House of Quality
PE	-	Polyethylene
PP	-	Polypropylene
PS	-	Polystyrene
PSM	-	Projek Sarjana Muda
PVC	-	Polyvinyl Chloride
QFD	-	Quality Function Deployment
UTS	-	Ultimate Tensile Strength

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CHAPTER 1
INTRODUCTION

This chapter contains the background of study, objectives, scope and problem statement to be achieved in this project and also the scope of the study which clearly defined the limit of this study and how depth the study. Other than that, this chapter provides a structure of the report which generally describes on chapter division and related contents to that particular chapter. In overall, it summarizes the progress of the whole project, describing how the whole project has been done.

1.1 Background of Study

Fryer basket is one of the kitchen appliances that used for deep frying. It is mostly used in food industry. Fast food companies such as Mc Donalds, KFC, Marrybrown, and Burger King used it a lot in their business to fry the food such as chicken, nugget and fries. This project studies about the design optimization of fryer basket by using Finite Element Analysis (FEA). Information from various sources such as reference book, magazines and internet are reviewed, summarized and cited to explore their potential and applicability.

In nowadays design, CAD technology is used as one of the method to develop geometric model of the product in three dimensional (3D) form, such that the geometric and manufacturing requirements can be examined. CAD software such as CATIA and SolidWorks provide the FEA options. FEA is a powerful analysis tool that can be applied to a range of engineering problem. The finite element modelling process can be used for discrediting the complex geometries into small fundamental volumes called finite element (Tan, 2011). Then, the governing equations and material properties for the elements is possible to write. These equations are then assembled by

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taking proper care of results that describe the behaviour of the original complex body being analysed. Application of FEA is no limited to mechanical system alone but to range of engineering problem such as stress analysis, dynamic analysis, and deformation studies fluid flow analysis, heat flow analysis and other.

With the FEA software it is possible to try a number of alternative designs before actually going for a prototype manufacture. The use of FEA tools can converting the geometry into discretised element and calculating various properties for each element such as geometry, material properties, constraint and loading. This forms the input for the analysis. It also can generating the finite element mesh by making a suitable approximation to the geometry. Then it can calculate the nodes and element properties and allowed the material properties to be specified.

1.2 Problem Statement

Fryer basket is one of the important component in deep fryer machine that used for deep frying cooking method. The existing design has some disadvantages that can be improved. Firstly, the price of the fryer basket. In today's market, the existing fryer basket is sold for a high price. This happened because of the material itself where manufacturer used stainless steel because it has a good quality and properties that very suitable for cookware. By optimizing the design of fryer basket and minimizing material usage of stainless steel, it can be produced with low manufacturing cost (Moreth, 2001). It is brilliant to design fryer basket that greatly reduce the consumption of raw material (Cheng, 2013). Then, it can be sold at affordable price. Next, is about the handle of fryer basket. The handle that being attached to the basket is not strong enough to support the load put in the fryer basket. It tend to slightly bend after a long use.

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1.3 Objectives

In this project, the objectives are:

a) To study the design of existing fryer basket.

b) To optimize fryer basket design using Finite Element Analysis (FEA).

c) To suggest best design and analysis of fryer basket.

1.4 Scope

The aim of this project is to improve and optimize the existing design of fryer basket. This project focusing on the fryer basket that commonly used in fast food restaurant. In achieving this goal, the existing fryer basket will be drawn by using a CAD software (SolidWorks) and analyse the existing design by using FEA (Finite Element Analysis). After analysing the problem with the existing design, then the new design will be generate and analyse. The analysis result of the existing design will be the guideline in designing the new fryer basket. The redesign and optimization process will be conducted until the best result and design created.

1.5 Report Summary

This report is divided into five main parts, which is each of them consist of the explanation related to the chapter.

Chapter 1: Introduction
This chapter describes the background of study, objectives, scope, and problem statement. The overview of the project is explained roughly in this chapter.

Chapter 2: Literature Review
This chapter reviews the information that related to the project title and problem statement which had been summarized. The information get from book, journals, previous studies and research is used as a guideline for this project.

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Chapter 3: Methodology

In this chapter, all the detailed method that used to achieve the objectives of this project is explained. Besides that, this chapter include the project Gantt chart and project planning for PSM 1 and also PSM 2.

Chapter 4: Result and Discussion

This chapter discuss the result of the research and argument about the design. All the methodology that have been mentioned in Chapter 3 is applied here.

Conclusion and Recommendation

This chapter concludes the project findings and research. The recommendation or suggestions are included to improve the project findings in the future.

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