

DESIGN AND DEVELOPMENT OF VACUUM FORMING MACHINE

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**This report is submitted
in fulfillment of the requirement for the degree of
Bachelor of Mechanical Engineering (Design and Innovation)**


Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MAY 2017

DECLARATION

I declare that this project report entitled “Design and Development of Vacuum Forming Machine” is the result of my own work except as cited in the references


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Date : 13/6/2017

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovation).

Signature  ..
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Date : 13/6/17

DEDICATION

To my beloved mother and father

ABSTRACT

Vacuum forming machine is a machine that performs vacuum forming process in which a plastic sheet is heated to suitable temperature, stretched around into a mould and then conformed to the mould by creating vacuum pressure between the plastic sheet and surface of mould. There are many products manufactured by vacuum forming process. They are becoming increasing popular because of the low cost and convenient modification. However, the vacuum forming machine in the marketplace is expensive and large. This would be extremely unwise to buy an expensive vacuum forming machine just for personal use or the small amount of usage. Therefore, in this project, a simple and low cost vacuum forming machine was designed and developed for learning purpose. At first, the dominant requirements were determined, that is low manufacturing and maintenance cost, easy to operate, safe and etcetera. In this project four design concept of vacuum forming machines were designed with the methods such as brainstorming, objective tree, morphological chart and etc. The Pugh method was used to select the best design concept. All designs were evaluated based on product design specifications that are performance, appearance and economy. Finally, Design concept 4 was selected due to its outstanding features compared to others. Then, Design concept 4 was drawn in detail by Software CATIA V5R20. Product analysis were carried out in order to calculate and determine the required amount of power supply to heat the plastic sheet until it is soften. The results have known that 1.5mm thickness of ABS plastic sheet can be soften and formed after being heated at around 44 W in 3 min. After that, a prototype was fabricated and tested. The estimated price for the prototype of vacuum forming machine is about RM 108.89.

ABSTRAK

Vacuum forming merupakan sebuah tehnik sederhana yang menggunakan selembar plastic yang dipanaskan pada temperatur tertentu, dan kemudian diregangkan ke dalam sebuah mould atau cetakan. Vakum membentuk Mesin adalah sebuah mesin yang melaksanakan proses tersebut. Pada masa kini, banyak produk di sekeliling kita adalah dihasilkan oleh proses ini. Mereka menjadi semakin popular kerana kos rendah dan pengubahsuaian mudah. Walau bagaimanapun, vakum membentuk Mesin adalah mahal dan besar di pasaran. Oleh itu, kebanyakan pengguna tidak mampu membeli mesin ini untuk tujuan perobadi. Oleh itu, vakum membentuk Mesin yang mudah dan murah telah direka dan dibangunkan dalam projek ini. Keperluan pelanggan terhadap mesin ini telah ditentukan sebelum mesin direka dan dibentuk. Dalam projek ini, empat jenis mesin telah direka dengan menggunakan kaedah seperti brainstorming, objective tree, carta morfologi dan sebagainya. Kaedah Pugh telah digunakan untuk memilih reka bentuk yang terbaik. Semua rekabentuk telah dinilai berdasarkan spesifikasi produk seperti prestasi, rupa dan ekonomi. Akhirnya, konsep 4 telah dipilih kerana ciri-ciri yang cemerlang berbanding dengan konsep-konsep lain. Kemudian, konsep 4 telah dilukis secara terperinci dengan menggunakan Perisian CATIA V5R20. Analisis produk telah dijalankan untuk mengira dan menentukan jumlah bekalan kuasa yang diperlukan untuk memanaskan lembaran plastik sehingga ia melembutkan. Keputusan menunjukkan bahawa lembaran plastik ABS yang ketebalan 1.5mm boleh dilembutkan dan dibentuk selepas dipanaskan dengan 44 W selama 3 min. Prototaip telah dibina dan diuji. Harga anggaran prototaip mesin adalah RM 108.89.

ACKNOWLEDGEMENT

Firstly, I would like to express my outmost gratitude to Universiti Teknikal Malaysia Melaka for providing me an opportunity to pursue Projek Sarjana Muda (PSM) or Final Year Project (FYP) as a partial fulfillment of the requirement for the degree of Bachelor of Mechanical Engineering (Design and innovation). Next, I would like to express my deepest appreciations to my project supervisor; Dr Mohd Nizam bin Sudin, for consultants throughout the project. Thank you for always guide me and advise me in producing an excellent report. Besides that, I would like to thank my parents and friends that always motivate me and support me in accomplishing the project. Thank you for trying your best to assist me during prototype development.

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LIST OF ABBEREVATIONS

UTEM	Universiti Teknikal Malaysia Melaka
FKM	Faculty of Mechanical Engineering
ABS	Acrylonitrile butadiene styrene
PVC	Polyvinyl chloride
PS	Polystyrene
PP	Polypropylene
PC	Polycarbonates
FIG	Figure
Eq	Equation

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APPENDIX

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

According to Collins Dictionary, vacuum forming is a process in which a heated thermoplastic sheet is shaped by pressing it toward a mould and applying suction. Vacuum forming machine is a machine that performs vacuum forming process in which a plastic sheet is heated to suitable temperature, stretched around into a mould and then conformed or fit to the mould by creating vacuum pressure between the plastic sheet and surface of mould.

There are few steps and process involved in vacuum forming process. First, a mould is made and put on the platens of the vacuum forming machine. Then, a thermoplastic sheet is clamped in place and placed above the mould. The heater, which is positioned above the plastic, will heat up to warm the plastic. Then, the mould is moved up to the hot flexible and mouldable plastic sheet. The vacuum is switched on and all the air which is under the plastic will be expelled out, allowing the plastic to form the shape of the mould. Finally, the sheet is moved from its mould and excess parts are cut and trimmed.

Nowadays, many products around us are manufactured by vacuum forming process. They are becoming increasing popular because of the low cost and convenient modification. The most common products that made from vacuum forming include open plastic containers, food packaging, sink units, and others. The vacuum forming process has many advantages over blow moulding, injection

moulding and other plastic forming processes. However, it is too expensive and large; it is unwise to buy it just for the small amount of usage. Therefore, in this project, a low cost, small size vacuum forming machine will be designed and analyzed for educational purpose.

According to Plasticpedia, vacuum forming is “comparatively low cost tooling” it requires less sophisticated tools and relatively inexpensive materials to produce the mould. Large parts can be produced from one sheet of plastic to save the quantity cost. Besides that, small runs can be prototyped economically compared to other processes. Furthermore, vacuum forming is also a time efficient plastic forming process. Engineer don't need to spend many time on the designing the product because the vacuum forming process is a simple manufacturing process. Nowadays, vacuum forming has become technically controlled through the simulation process with the necessary expertise. Therefore, vacuum forming is a great potential for development of processing methods in the plastic processing field.

1.2 PROBLEM STATEMENT

The existing vacuum forming machine in the marketplace is expensive and large. This would be extremely unwise to buy an expensive vacuum forming machine just for personal use with the small amount of usage. Therefore, a simple and low cost vacuum forming machine will be designed and developed for learning purpose.

1.3 OBJECTIVE

The objective of this research project is to design and develop a simple and low cost vacuum forming machine which can produce many different products from thermoplastic effectively.

1.4 SCOPE OF PROJECT

The scopes of this project are:

This project will focus primarily on the design and development of the vacuum forming machine. A simple and low cost vacuum forming machine will be designed and drawn with the aid of CATIA software. Engineering design method and tools such as the morphological chart, Decision Matrix, and others may be applied in designing the vacuum forming machine. Finally, a simple and low cost prototype will be built up as a teaching aid in university.

Project Limits/Boundaries/Work Elements:

The vacuum forming machine will be designed for manual operation. The type of plastic material will be used is ABS plastic. ABS is a thermoforming plastic that can easily be vacuum-formed or shaped by heating and bending. It is thin enough that it can be cut with scissors or a utility knife. In this project, the temperature of heating will be fixed to around 150 degree Celsius; this is based on the formability of selected materials. Besides that, this project will not cover simulation of air flow inside the vacuum forming machine. Due to the limitation of budget, the size and materials used in prototype development will not identical to the proposed solution. Therefore, the result of product testing may be different due to the difference in materials.

1.5 GENERAL METHODOLOGY

In order to achieve the objectives of the project, there are few tasks that need to be carried out, those actions are listed as below.

i. Identify Problem

The existing problem will be identified by conducting the literature review to many reading sources such as journals, research papers, articles and other relevant reading materials.

ii. Customers' Requirements

A market analysis will be carried out to identify and clarify the customer's needs. After that, all the customers' requirements will be organized in an objective tree for a better view. Then, a functional analysis will be conducted to know the main function and sub-functions of the product. Finally, and product design specification will be set according to market analysis results and objective tree.

iii. Conceptual Design

Brainstorming will be used to generate a large quantity of alternative for each function of the proposed solution. All the proposed solutions will be evaluated by Decision Matrix in order to select the best solution.

iv. Detail Design

After the best conceptual design is chosen, the researcher will design their product in more detail way which includes types of materials used for the product, manufacturing cost, manufacturing process and the geometric dimension of the product. Lastly, the product will be drawn by using CATIA V5R20.

v. Product Analysis

Once the product is well defined, a complete analysis is conducted. In the analysis process, the integrity of the design in terms of its safety, material, manufacturing process and cost concerns will be evaluated

vi. Prototype Development

A simple and low cost prototype will be built up based on the final solution. The size and materials used in the prototype will not identical to the actual product due to budget.

vii. Report writing

All the study and knowledge regarding design and development of vacuum forming machine will be recorded in the paperwork for future reference.

The methodology of this study is summarized in the flow chart as shown in Figure 1.1.

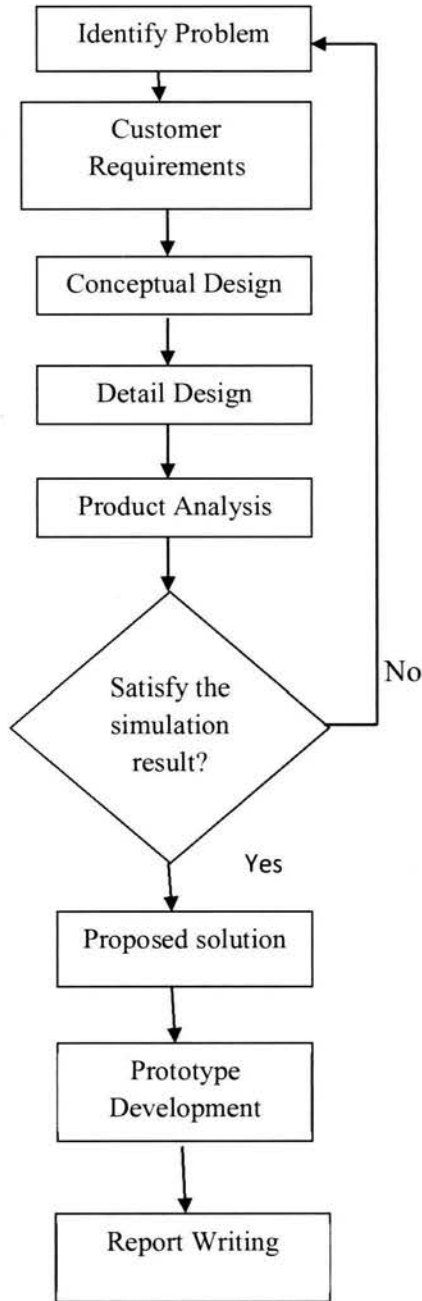


Figure 1.1: Flow chart of the methodology