UNIVERSITI TEKNIKAL MALAYSIA MELAKA

An Improvement of Drinking Water Container Design Focusing on Structural Aspect

Thesis submitted in accordance with the requirements of the
Universiti Teknikal Malaysia Melaka for the Degree of
Bachelor of Engineering (Honours) Manufacturing (Design)

By

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS TESIS*

JUDUL: AN IMPROVEMENT OF DRINKING WATER CONTAINER DESIGN FOCUSING ON STRUCTURAL ASPECT

SESI PENGAJIAN : 2006/2007

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This thesis submitted to the senate of UTeM and has been accepted as fulfillment of the requirement for the degree of Bachelor of Engineering (Honours) Manufacturing (Design). The members of supervisory committee are as follow:

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PN. RUZY HARYATI BINTI HAMBALI

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ABSTRACT

The title of this project is "An improvement of drinking water container focusing on structural aspect". The aim of this project is to improve the design of drinking water container that is more comfortable for the average age of kids to adult. Five current design of drinking water container was studied in order to get basic understanding. After this stage, all drinking water and mineral water of 500ml exist in the market were gathered, then 5 of them had been chosen. This water container is made from polyethylene terephthalate (PET). An improvement structure aspect was initiated focusing on 3 main parts only. The parts are shoulder part, body part and bottom part. The process selection was important to define a good design based on alternative concept of drinking water container. New concept of drinking water container was produced according to screening and scoring concept. Next, new drinking water container was designed using solidwork software. New drinking water container prototype was produced using ZPrinter machine. Lastly, new prototype with 5 current drinking water containers was compared using survey.

ABSTRAK

Tajuk projek ini adalah "Meningkatkan rekabentuk botol air minuman fokus kepada aspek struktur". Matlamat projek ini adalah untuk meningkatkan rekabentuk botol air minuman supaya lebih selesa kepada semua peringkat umur sama ada kanak-kanak mahupun dewasa. Lima daripada botol air minuman sedia ada di kaji untuk mendapatkan kefahaman secara asas. Kemudian, semua botol air minuman yang berisipadu 500ml di pasaran di kumpulkan dan 5 daripadanya dipilih. Botol air minuman ini di buat daripada *polyethylene terephthalate* (PET). Peningkatan rekabentuk ini di fokuskan kepada 3 bahagian utama. Bahagian itu ialah bahagian bahu botol, bahagian tubuh botol dan bahagian bawah botol. Proses pemilihan sangat penting untuk mengenalpasti rekabentuk yang elok berdasarkan konsep alternatif botol-botol air minuman yang disebutkan tadi. Lukisan konsep botol air minuman baru dihasilkan berdasarkan konsep *screening and scoring*. Kemudian, botol air minuman baru dilukis menggunakan *solidwork software*. Prototaip bagi botol air minuman dihasilkan menggunakan mesin ZPrinter. Akhir sekali, prototaip botol air minuman dengan 5 botol air minuman yang dipasaran tadi dibandingkan menggunakan teknik peninjauan kepada responden.

DECLARATION

I hereby, declare this thesis entitled "An Improvement of Drinking Water Container Design Focusing on Structural Aspect" is the result of my own research except as cited in the reference.

Signature : 

Author's Name : MOHD HAFIQ IQUAN BIN MOHD YUSOFF

Date : 8 MAY 2007

DEDICATION

Firstly thank to Allah S.W.T for the opportunity to finish this project. I owe this project and my true happiness to my beloved parent. Since the day I started going to this university until today, they are very caring to supporting me.

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Praise to Mighty Allah for His Grace and Mercy in helping me throughout this research and to guide me in completing this study in time.

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CHAPTER 1

INTRODUCTION

1.1 Background Introduction

Generally the scope of manufacturing engineering (design manufacturing) course is to design a product and machine. The student also knows the methodology design like design for assembly (DFA) and Design for manufacturing (DFM). Beside that it focuses for idea presentation, produce new product, visualizing product before process making and marketing. The graduates from this course need to know software of design and the design process to produce component and products. In manufacturing engineering characteristic and properties of the materials are very important because these determine the advantages and limitation of product application and cost to develop the product.

This project thesis will highlight about the design improvement of drinking water container design focusing on structural aspect. This study will focus to the design of existing drinking water container in market. There many type of drinking water container and have various shape and structure and for this thesis specific to the drinking water container and mineral water container exactly focus on the local market. The variation of bottle's shape depends on the usage, material type and using blow mould machine. Some examples include polyethylene (PE) squeeze bottles for washing-up liquid, polyvinyl chloride (PVC) for cooking oils and fruit squash bottles, and polyethylene terephthalate (PET) for carbonated beverage bottles and drinking water container. As there are many possible shapes and sizes to consider, this paper focuses only on the design of bottles made from PET, namely drinking

bottles. The process to make a plastic bottle from polyethylene terephthalate (PET) using stretch blow molding. In the stretch blow molding (SBM) process, the plastic is first molded into a "preform" using the Injection Molded Process. These preforms are produced with the necks of the bottles, including threads (the "finish") on one end.

1.2 Objectives

- To identify various shape and design of existing drinking water container.
- To produce new prototype of drinking water container
- To improve the drinking water container design focusing on structural aspect.

1.3 Scope of Study

- Study various shape and design of existing drinking water container.
- Select 5 current design of drinking water container.
- Produced new concept of drinking water container according to screening and scoring concept.
- Design new drinking water container using solidworks software.
- Produce new drinking water container prototype using ZPrinter 310 machine.
- Compare new prototype with 5 current drinking water container using survey.

1.4 Problem Statements

Nowadays, most of the drinking water container have a different structure depends on design of the brands and the types of drinking water container. From varieties of drinking water container design, we want to know the best design that good in structural design.

1.5 Importance of Study

The project thesis is a basic guideline to know how the concept selection is used to improve an existing product such as drinking water container. Nowadays, there are many types of concept that exist in market. From here, the concept comparison was important to know how and the best concept was generated based for reference. The concept screening and scoring was the best concept selection is to get the best design concept. A prototype was produced and survey was done to get comparison with existing drinking water container. From the survey data, the best design of drinking water container based on structural aspect will be known.

CHAPTER 2

LITERATURE REVIEW

2.1 Background Introduction

Traditionally, containers used for the storage of products for human consumption were made of glass. Typical desirable glass characteristic include transparency, in deformability and perfect label fixation. Nevertheless, because glass is fragile, easy breakable and heavy, it has become cost prohibitive, due to the high number of bottles breaks during handling. Moreover, as a result of breaks preventive measure and weight, the transportation expenses associated with the glass greatly increase the cost of the product.

Plastics can be divided into two major categories: Thermosets and Thermoplastics. A thermoset is a polymer that solidifies or sets irreversibly when heated. Thermosets are valued for their durability and strength and are primarily in automobiles and construction. Others are used for adhesives, inks and coatings. A thermoplastic is a polymer that softens when exposed to heat and returns to its original condition when cooled to room temperature.

Termoplastics can be shaped easily and are used for products such as soft drink bottles, milk jugs, floor coverings, credit cards and carpet fibers. Plastic resins are processed in several ways including extrusion, injection molding, blow molding and rotational molding. All of the processes involve using heat and pressure. (Plastics Recycling 201)

Descriptions of bottles generally require some explanations. As with all specialties, the study of bottles has its own set of nomenclature. Refer to **Figure 2.1**.

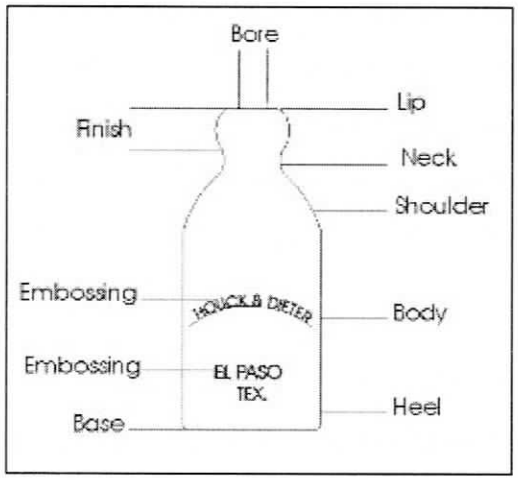

Figure 2.1: Bottle nomenclature

i. Bore - the inside diameter, also known as the throat.
ii. Lip - the extreme upper surface
iii. Neck - the usually narrow area between the shoulder and the finish
iv. Shoulder - the change in slope where the body begins to narrow to form the neck
v. Body - the central section of the bottle, usually containing advertisements and messages
vi. Heel - the lower section of the body, just above the base
vii. Base - the part of the bottle that actually contacts a surface, also known as the resting point
viii. Embossing - raised glass lettering (or pictures) that are an integral part of the molding process.
ix. Finish: The final, upper section of the bottle, sometimes including part or all of the neck (Bill Lockhart 2001)

2.2 Blow Molding

Blow molding is a molding process in which air pressure is used to inflate soft plastic into a mold cavity. It is an important industrial process for making one-piece hollow plastic parts with thin walls, such as bottles and similar containers. Since many of these items are used for consumer beverages for mass markets, production is typically organized for very high quantities. The technology is borrowed from the glass industry with which plastics compete in the disposable or recyclable bottle market.

Blow molding is accomplished in two steps: (1) fabrication of a starting tube of molten plastic, called a parison (same as in glass-blowing); and (2) inflation of the tube to the desired final shape. Forming the parison is accomplished by either of two processes: extrusion or injection molding.

Extrusion Blow Molding **(Figure 2.2)**. This form of blow molding consists of the cycle illustrated below. In most cases, the process is organized as a very high production operation for making plastic bottles. The sequence is automated and usually integrated with downstream operations such as bottle filling and labeling. It is usually a requirement that the blown container be rigid, and rigidity depends on wall thickness among other factors.

Extrusion blow molding: (1) extrusion of parison; (2) parison is pinches at the top and sealed at the bottom around a metal blow pin as the two halves of the mold come together; (3) the tube is inflated so that it takes the shape of the mold cavity; and (4) mold is opened to remove the solidified part.

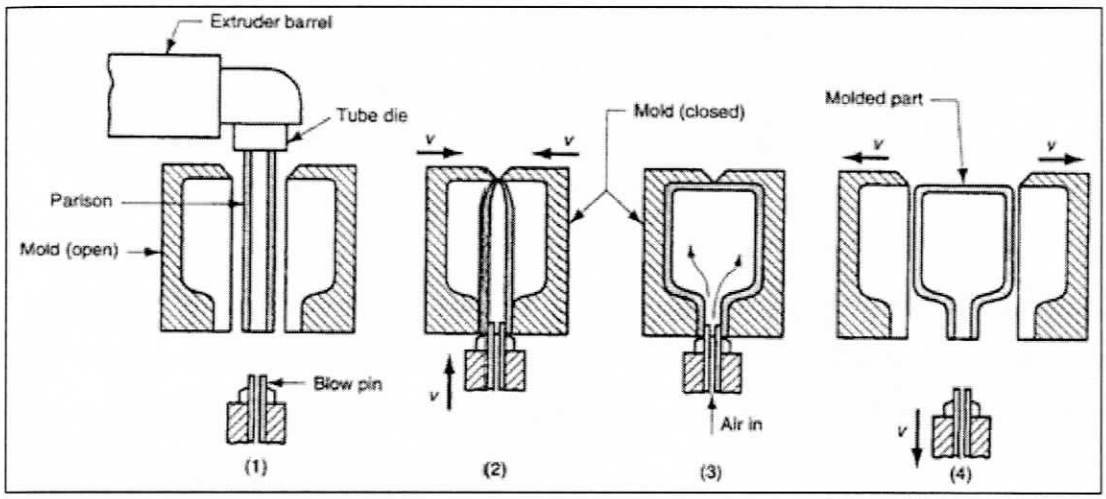

Figure 2.2 : Extrusion blow molding

Injection Blow Molding **(figure 2.3)**. In this process, the starting parison is injection molded rather than extruded. A simplified sequence is outlined in below. Compared to its extrusion-based competitor, the injection blow-molding process has a lower production rate, which explains why it is less widely used.

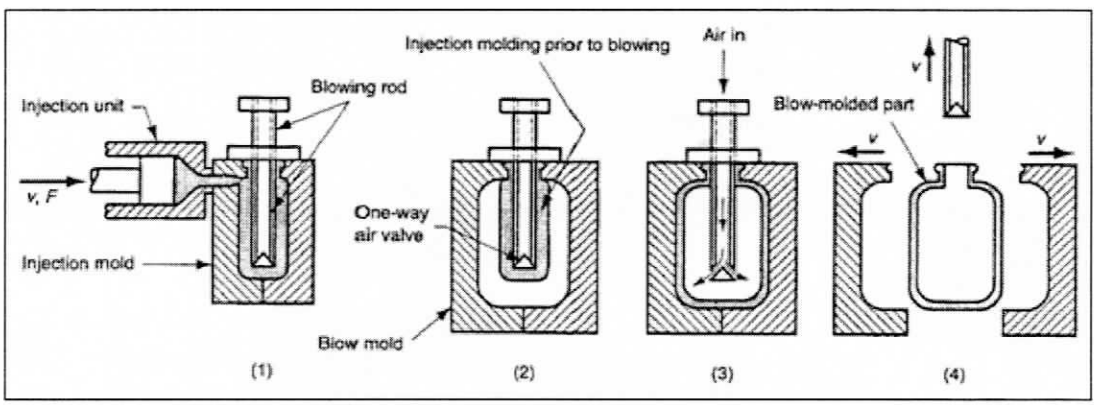

Figure 2.3: Injection blow molding

Injection blow molding: (1) parison is injection molded around a blowing rod; (2) injection mold is opened and parison is transferred to a blow mold; (3) soft polymer is inflated to conform to a blow mold; and (4) blow mold is opened and blown product is removed.

In a variation of injection blow molding, called stretch blow molding **(Figure 2.4)**, the blowing rod extends downward into the injection molded parison during step 2, thus stretching the soft plastic and creating a more favorable stressing of the polymer than conventional injection blow molding or extrusion blow molding. The resulting structure is more rigid, with higher transparency and better impact resistance. The most widely used material for stretch blow molding is polyethylene terephthalate (PET), a polyester that has very low permeability and is strengthened by the stretch-blow-molding process. The combination of properties makes it ideal as a container for carbonated beverages.

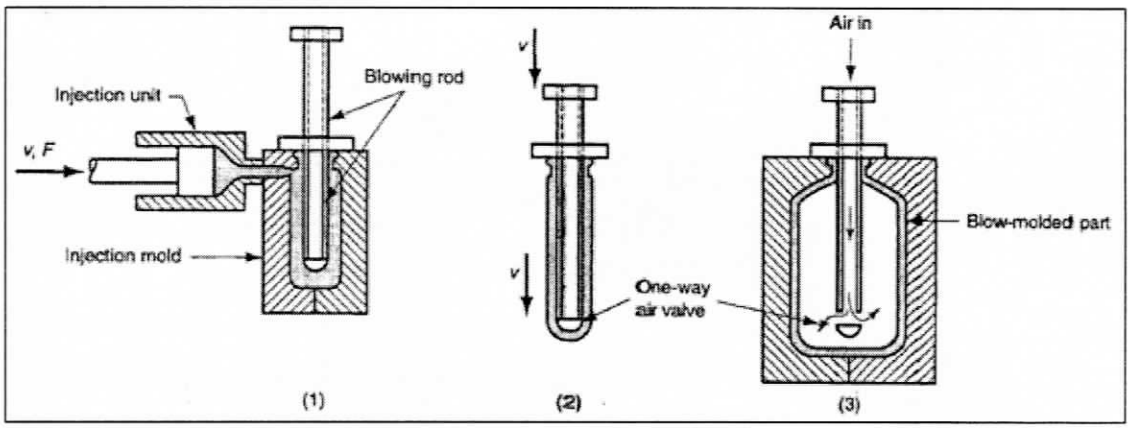

Figure 2.4: Strech blow molding

Stretch blow molding: (1) injection molding of the parison; (2) stretching; and (3) blowing.

2.2.1 Materials and Products.

Blow molding is limited to thermoplastics. Polyethylene is the polymer most commonly used for blow molding; in particular, high density and high molecular weight polyethylene (HDPE and HMWPE). In comparing their properties with those of low density PE given the requirement for stiffness in the final product, it is more economical to use these more expensive materials because the container walls can be made thinner. Other blow moldings are made of polypropylene (PP), polyvinylchloride (PVC), and polyethylene terephthalate (PET).(Offshoresolutions)

2.3 Concept Selection

Concept selection is perform is often performed in two stages as a way to manage the complexity of evaluating dozens of product concept. Screening is a quick, approximate evaluation aimed at producing a few viable alternatives. Scoring is more careful analysis of these relatively few concepts in order to choose the single concept most likely to lead to product success. (Karl T Ulrich, Steven D. Eppinger)

Both stages, concept screening and scoring, follow a six-step process which leads the team through the concept selection activity. The steps are:

i. Preparing the selection matrix
ii. Rate the concepts.
iii. Rank the concepts.
iv. Combine the improve the concepts
v. Select one or more concepts
vi. Reflect on the results and the process

2.3.1 Concept Screening

Concept screening is based on the methods development by the Stuart Pugh in the 1980s and often called Pugh concept selection (Pugh, 1990). The purposes of this stage are to narrow the number of concepts quickly and to improve the concepts.

Step 1: Prepare the Selection Matrix
To prepare the matrix, the team selects a physical medium appropriate to the problem at hand. Individual and small groups with short list criteria may use matrices on paper.
Next, the inputs (concepts and criteria) are entered on the matrix. Although possibly generated by different individual, concepts should be presented at the same level of detail meaningful comparison and unbiased selection.