

INNOVATIVE DIE DESIGN FOR SHEET  
METAL STAMPING

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA  
2014



## **UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

### **INNOVATIVE DIE DESIGN FOR SHEET METAL STAMPING**

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

By

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**TAJUK: INNOVATIVE DIE DESIGN FOR SHEET METAL STAMPING**

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I hereby declared this report entitled “Innovative Die Design for Sheet Metal Stamping”  
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## **APPROVAL**

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) (Hons). The member of the supervisory committee is as follows.

.....

Supervisor

(PROF. DR. MOHD. RAZALI BIN MUHAMAD)

## **ABSTRAK**

Dalam reka bentuk acuan, mekanisme alat adalah bahagian penting dalam proses pengepresan logam, di mana teknologi ini adalah aplikasi asas dalam industri automotif, kenderaan berat dan aeroangkasa. Laporan ini menerangkan idea untuk menghasilkan reka bentuk alat yang inovatif dalam pengepresan logam kepingan. Untuk menentusahkan idea rekabentuk ini, satu mekanisme alat ditetapkan dalam acuan bagi membuat proses bebenang kepingan logam sekunder dengan acuan progresif. Dengan menggunakan idea seumpama ini dalam acuan, ia pasti akan mengurangkan proses sekunder seperti bebenang pada logam kepingan. Proses bebenang sekunder boleh diintegrasikan dengan proses primer untuk merekabentuk mekanisme alat yang cekap. Dengan menggunakan tenaga hentaman daripada acuan atas, menukarkan pergerakan putaran menegak ke pergerakan putaran mendatar untuk melakukan pergerakan depan dan belakang ke arah logam kepingan 2 mm. Teknik ini dibangunkan dengan menggunakan Konsep Pemilihan Pugh. Dengan melaksanakan kaedah ini, tiga lakaran dibentuk yang kemudiannya ditapis menggunakan teknik pemilihan konsep. Akhir sekali, rekabentuk yang terpilih akan dibangunkan secara terperinci dan pemasangan dengan menggunakan perisian tiga dimensi. Keseluruhan projek ini adalah untuk mengkaji, rekabentuk dan membangunkan acuan pengepresan logam kepingan yang lebih maju dan cekap dalam proses pengepresan logam kepingan.

## **ABSTRACT**

In die design, tool mechanism is an important portion in the metal stamping process, where this technology is fundamental application in automotive, heavy vehicle and aerospace industries. This report presents an idea to produce innovative die design in sheet metal stamping. To implement this design idea, a tool mechanism is fixed in the die in order to place the secondary sheet metal threading process in the progressive die. By applying this kind of idea in die, it definitely will minimize the secondary process such as threading. The secondary threading process can be integrated with the primary process by design an efficient tool mechanism. It will convert the impact from upper die to vertical rotational movement, to a horizontal rotational movement that perform reciprocally toward the 2 mm sheet metal. This technique are developed by applying the Pugh Concept Selection. By using this method, three sketches of design are filtered using concept selection technique. Finally, the selected concept design is developed in detail and assembly by using cad modeling software. The entire project is to study, design and develop a sheet metal stamping die tool mechanism which more advanced and efficient in the sheet metal stamping process.

## DEDICATION

Special dedicate to all persons that help me in completing my final year project especially to my project supervisor Prof. Dr. Mohd. Razali Bin Muhamad.

To my beloved parents, my family, thank you for your comfort and supported me...

And not forgotten, Thanks to my lecturers and friends and Mr Boey Kok Hoong,  
Managing Director of Solid Presicion Engineering Sdn Bhd...

This report is fully dedicated to all of you...



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## LIST OF ABBREVIATIONS

3D	-	3 Dimensional
PSM	-	Projek Sarjana Muda
UTeM	-	Universiti Teknikal Malaysia Melaka
ETC	-	Extra
BOM	-	Bill of Material



# **CHAPTER 1**

## **INTRODUCTION**

This chapter presents the background of the final year project. This project will focus on introducing new ideas in sheet metal stamping die design. Moreover, this chapter mainly explains about the problem statement followed by the objectives and scope of the project.

### **1.1 Background**

Sheet metal stamping is a metal working process that use male dies and females die to perform forming or separating sheet metal into parts. There are several types of processes such as blanking, punching, bending and many more. This process can occur in a single stage operation or it can occur through a series of stages, depending on the part.

Sheet metal can be easily shaped into thin and flat pieces. There are a variety of types of metals made into the sheet metal such as aluminum, brass, copper, and nickel. Nowadays, sheet metal has applications in the automotive industry and aviation industry. It can be easily cut and bend. The most common operation in industrial forming of sheet metal is bending. In this operation, metal is plastically deformed and its shape is changed. Basically, the material is stressed beyond its yield strength and below the ultimate tensile strength from bending operation. However, it involves little changes on the material surface area.

Die design has been estimated to form the huge proportion of the overall cost of the process in order to produce the product. Besides that, it is also known as the critical stage where an innovative approach is required in order to design and manufacture high quality products at lower costs. The product design has to follow the rules to meet the specification to avoid encountering problems during the manufacturing process which is only wasting the time and costs from redesigning the product. Therefore a specific rule is an essential in designing and manufacturing products. By limiting the rule used to produce the design, it may minimal the die in the production area in order to minimize the cost.

Generally, bending is referred to as the deformation is on only one axis. A various and different shape can be produced in implementing the bending process by using standard die sets. The material needed to be bent is placed on the die and positioned it in place with gages. It is held in place with hold-downs. In manufacturing, the bending process includes press brake, air bending and bottoming or coining. In order to produce the die and simulate it need the help of software that can design the die of metal stamping. This tool will help the designer to apply the various factors in order design die that produce quality product with effective performance.

## **1.2 Problem Statement**

Design the innovative die for metal stamping process is a very important stage in manufacturing field. It is because the product performance, product quality and final cost of the product are more influential in this stage. Therefore, following the rules that meet the specification only can produce a high quality product. In the metal stamping process, there are various limitations in the mechanical press die.

The die movement usually will be on the vertical motion only. That cannot perform any work on the side of the metal plate once it is bended. All the mechanical press also did not have the CNC feature that causes the part (sheet metal) is move one direction and cannot turn the part so can perform any process from vertical motion of the stamping machine.

### **1.3 Objectives**

- (a) To study the design of tool and die in metal stamping.
- (b) To design the tool mechanism for sheet metal stamping dies.

### **1.4 Scopes**

The scope of the research, including:

- (a) Design tool mechanism that capable of converting the vertical motion to horizontal rotational motion for sheet metal stamping dies.
- (b) Design a tool for sheet metal stamping die with new ideas that will combine the secondary manufacturing process with primary sheet metal stamping process.
- (c) To project will focus on the progressive die with sheet metal thickness 2 mm.

## **1.5 Outline of the Report**

This project is displayed in good order to convey a better understanding about overall of the study. In order that, an outline of the chapter has been formed to briefly explain and summarize the content of the entire chapter. There are 5 chapters that will represent this project. In the following will be briefly discussed about every chapter of this report.

Chapter one is related to the introduction of the project, which included background, problem statements, objective and scopes. That will be described specifically about the innovative die design in sheet metal stamping.

Chapter two is a study regarding the past findings that have been done by other people and theory related to sheet metal stamping. That will be elaborated in the mechanism and implementation of the project based on the patent followed by application. There are used many sources in order to find information regarding sheet metal and related topic. The source used to search in order support the detail in this chapter is books, journal, online and etc.

Chapter three is about the project flow that will describe about project plan. It will provide detailed information about the way data is collected and design developed. In also includes of methods used in chart form.

Chapter four is discusses the report outcome of the design development. It consists of technical requirement used in the design concept generation. Apart from that, there will be a selection of the conceptual design using Pugh Method, detail design, 3D modelling and final assembly.

Chapter five is a final chapter that will contain the discussion and conclusion. It will relate to explanation of important finding throughout this project. The recommendation for further study based on this project is also has suggested.

## **CHAPTER 2**

### **LITERATURE REVIEW**

In this chapter, will discuss the theory of sheet metal stamping, stamping die, and stamping machine. The literature review will find information about the previous finding in the same field. This information is important before continuing further with the project.

#### **2.1 Sheet Metal Stamping**

According to Kalpakjian and Schmid (2001), stamping contains different type of sheet-metal forming manufacturing processes, such as punching, piercing, forming, bending, notching, and trimming. This is a single stage operation where the stroke of press manufactures the desired form of sheet metal part, or could take place through a series of stages. The process is usually used the sheet metal to carry out the process related to it. When it comes to sheet metal it thickness should be 5mm and below.

This stamping process is about use dies to deform the flat metal sheets into a desire shape. This process is used to create every part of the household appliances to automotive industries. This process is used in large machinery to produce parts, but the

metal sheet also plays a role to be molded into shapes for household items like pots and pans.

The manufacturing process that related to stamping are punching, piercing, forming, and trimming. These processes are done with dedicated tooling also known as hard tooling. This kind of tooling is utilised to make high volume parts of one configuration of part design. All these die can be performed either at a multiple die station or single die stations and carried out a progression of operations, known as a progressive die.



Figure 2.1: Stamping machine (Internet Source, Citation from <http://www.stampingsofminnesota.com/stamping.html>)

Sheet metal stamping is well known manufacturing processes. From small battery cap to big automobile body parts are manufactured by stamping in large volume. As a consequence, the corporate may gain a significant outcome by doing small technological advance. According to Shang and Daehn (2010), sheet metal stamping is capable to produce a high production rate and low cost for fundamental technologies such as automotive that cause demands to innovate new development for this industry. Figure 2.1 above show the stamping machine that is capable produce high volume with low cost.

However, it also classified as a complicated process in the industries. This is due to this process sometimes need to produce the complicated design shape of the flat sheet metal. Ghosh (2004) claim that the formability of a sheet metal is its potential to attain the strains for the desired shape without rupture in a forming process. Anyway, its depend on the process factor, followed by the properties of sheet metal. Thus, the part gain enough strains to form the shape and not achieve its local failure criteria.

## 2.2 Sheet metal stamping process

A sheet metal stamping process is an operation to cut and form sheet metal into the intended shape. There are various kind of special machines that use to perform the sheet metal stamping processes. Furthermore, there are three important things that is part produce from the sheet metal; the stamping press and the stamping die. (Internet source, 2009, citation from : <http://www.thefabricator.com/article/toolanddie/sheet-metal-stamping-101-part-i>)

There were several stamping processes that are carried out using the stamping machine. Some of the processes are shown in Table: 2.1:

Table 2.1: Type of sheet metal stamping process

Type of process	Description
Punching	Create a hole in sheet metal using punch press
Blanking	the punch out pieces is the used part, while others are scrapped
Piercing	the punch out pieces is the scrap part, while others have used part
Notching	sheet metal cutting process working from the edge
Trimming	the cutting off unwanted part from a workpiece
Perforating	uniformly spaced hole punching in sheet metal
Bending	the process that deform metal by plastically for certain shape

### 2.2.1 Sheet metal

Sheet metal can be easily shaped and cut. It is one of the strongest materials used in sheet metal stamping processes. Due to its strength, it is capable of making parts that require a good bearing ability. In addition, metal has good corrosion resistance and is also a good electrical conductor. That makes it good for making electrical components. Sheet metal can be recycled and reused again. The sheet metal also has good visual appearance and strength. This is because parts made from sheet metal are aesthetically pleasing. (Internet source, 2009, citation from: <http://www.thefabricator.com/article/toolanddie/sheet-metal-stamping-101-part-ii>).

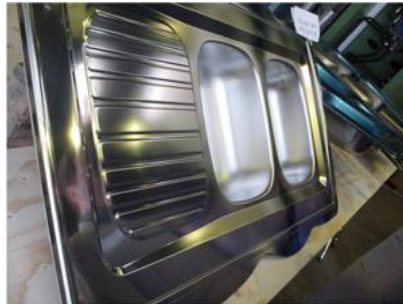


Figure 2.2: A stamped bright finish stainless steel sink (Internet source, 2009, citation from <http://www.thefabricator.com/article/toolanddie/sheet-metal-stamping-101-part-ii>)