CHAPTER 1.0 INTRODUCTION

1.1 Sheet Metal Forming

In metal forming, a piece of material is plastically deformed between tools to obtain the desired product. A special class of metal forming where the thickness of the material is small compared to other dimensions is called sheet metal forming.

Sheet metal forming is widely used as an effective production process. In 1998, 265 millon tons of steel sheets and 9 million tons of aluminium sheets were used for sheet metal forming processes which was approximately 35% of the total steel and aluminium production.

Currently, tool and die design activities related to sheet metal forming are based on previous experiences, personal experiences, rule of thumb approach and trial-error experiments. Tool and die manufacturers are not able to provide details such as effective operating windows, various alternative design options and the expected life span under static and dynamic loadings. This lack of engineering analysis and systematic approach are obstacles in seeking scientific solutions to further improve and optimize the design characteristics.

1.2 Objective of Study

In this study, an attempt will be made to resolve some of the issues mentioned earlier. The objectives of this study are :

1. To design a draw punch for the purpose of deep drawing a cylindrical cup
2. To improve the draw punch design by determining the static and dynamic reliability of the draw punch.
3. To determine the life span of the draw punch under dynamic loading.

The deep draw die was selected because the deep drawing operation is the most difficult and complex process as compared to other sheet metal stamping operations. It is a multi-stage drawing which requires design calculations and estimations to plan for a successful draw and redraw operations. Deep drawing was first developed in the 1700's and has become an important metal working process. It is now widely used in the automobile, packaging and home appliances industries.

In this study, the static and dynamic analysis were only performed on the draw punch. The methodology and analysis established here can be repeated to determine the reliability and life span of other die components in this draw die or any other new tools

The benefits of this approach are as listed below :

1. Savings in manpower and resources.
2. Savings in material as testing of prototypes are no longer necessary.

3. Cost savings due to faster solutions that are accurate, consistent, reliable and repetitive.
4. New results that were not available before. The impact of different variables in various situations can be evaluated effectively.

This design methodology is a positive shift from the current traditional and conventional manufacturing methods as the demands and expectations from sheet metal forming are continuosly increasing with regards to tight tolerances, complexity and durability. Using this new strategy, a wide range of new , consistent and reliable products are able to reach the customers' market quickly at a lower cost.

1.3 Methodology

The methodology used in this study is described below :

Step 1 : Product design

The proposed product design is determined and a part print is prepared.

Step 2 : Blank Development

The part print is used to initiate the blank development process. The required blank diameter is calculated taking into account the trim allowance.

Step 3 : Draw and Redraw Punch Design Calculations

Compressive loads and wrinkling problems can be reduced using redraw operations Drawing of a flat blank into a cup is called drawing. Converting the drawn cup into a smaller diameter and deeper cup is called redraw operations. At this step, the diameter and the length of the draw punch and redraw punches are determined.

Step 4 : Solid Modeling of the Punch, Die and Blankholder

Solid modeling of the punch, die and blankholder is performed with Pro Engineer, taking into account the necessary clearances between the components. By using commands like 'mate', 'insert'and'align', the components are assembled and the design intent is always maintained. Pro Engineer is based on a single data structure with the ability to change built into the system. Therefore when any change is made anywhere in the development process, it is propagated throughout the entire design-through-manufacturing process ensuring consistency in all the engineering deliverables. The data generated here can be linked to CNC machining centers to perform the machining processes accurately and repetitively.

Step 5 : Static Analysis on Draw Punch

A static load is a stationary force or moment acting on a component. It must have an unchanging magnitude, unchanging points of application and unchanging direction. A static analysis using Finite Element Method is performed to confirm the ability of the draw punch to withstand the calculated punch force in step 5 under static loading. Failure normally occurs when the stress level has exceeded the ultimate tensile strength.

Step 6 : Dynamic Analysis on Draw Punch

A dynamic analysis using Finite Element Method is performed to verify the functionality and reliability of the draw punch after undergoing repeated strokes. Failures due to dynamic loading are normally due to fatigue stress. Stresses during such failures are most of the times lesser than the ultimate tensile strength and yield strength of the component.

Step 7 : Life Span of Draw Punch

The life span of the draw punch whereby it can perform without any failures is determined. It is replaced during the routine preventive maintenance exercise and the costly breakdown maintenance can be avoided.

The flow chart for the design methodology is as shown in Figure 1.1.

1.4 Part Print of Cup

The desired final dimensions of this draw cup are as shown in Figure 1.2.

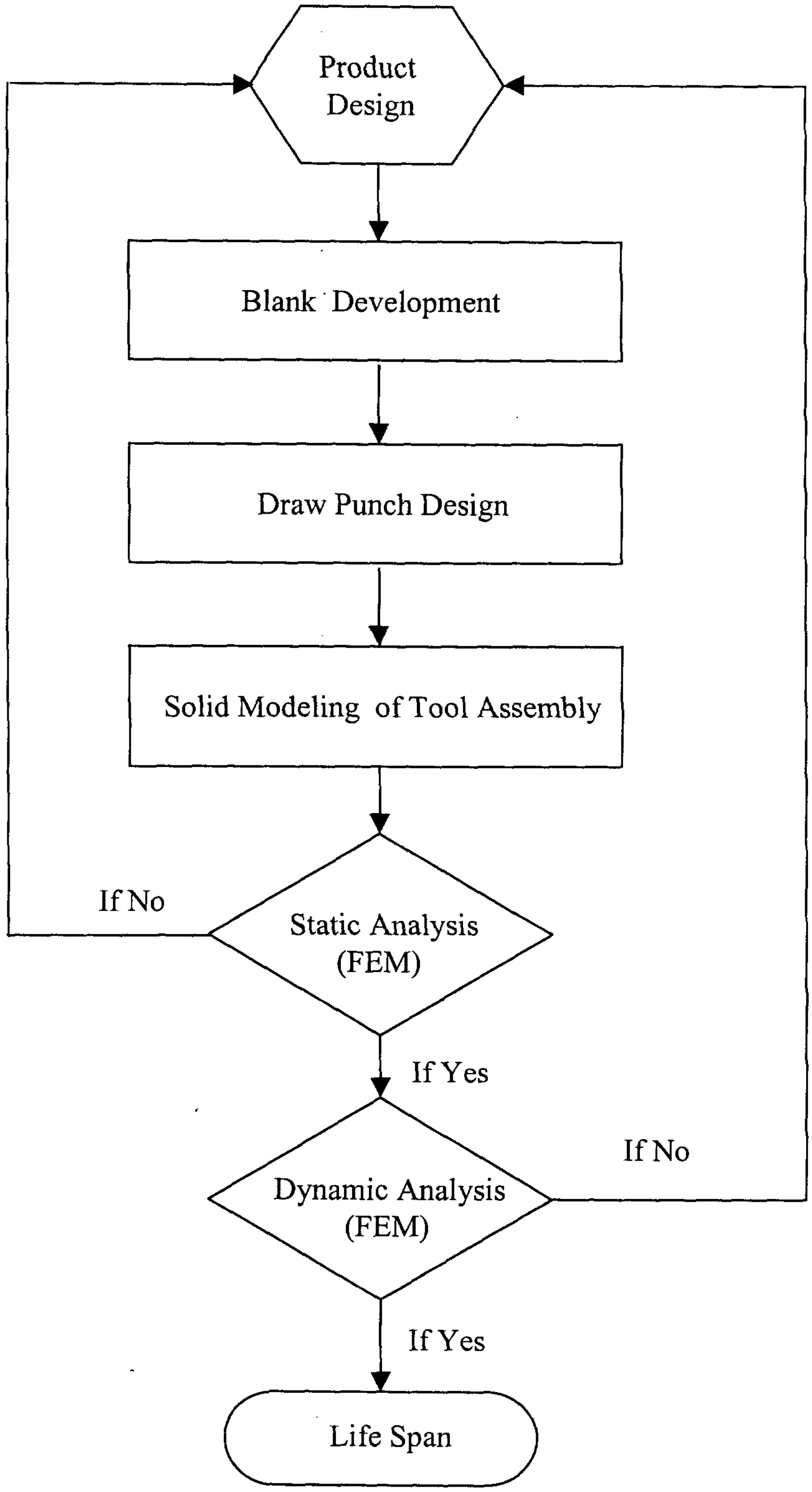

Figure 1.1 : Methodology Flowchart

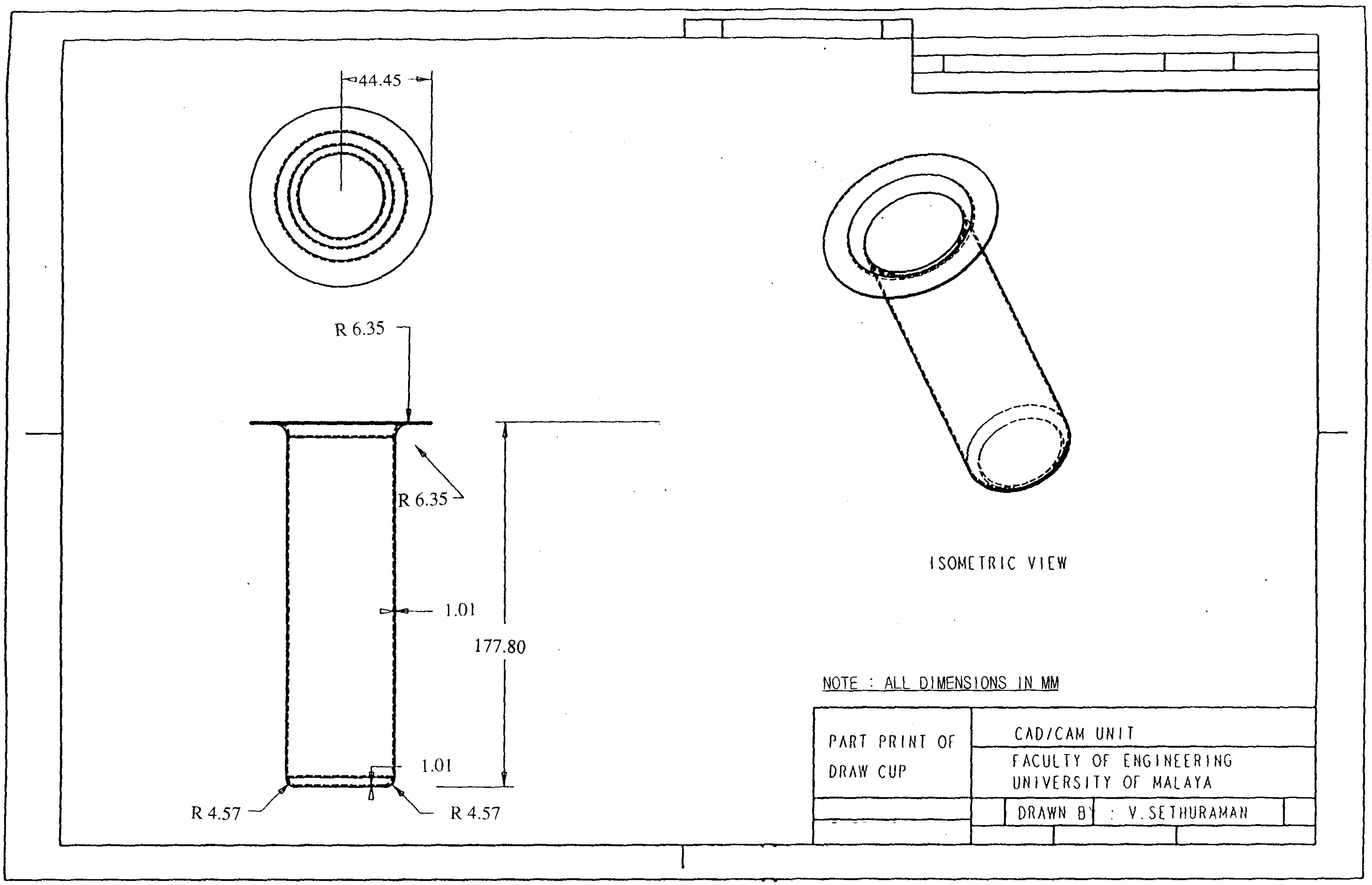

Figure 1.2 : Part Print of Draw Cup