UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND MODEL MAKING OF HEMMING JIG FOR CAR DOOR ASSEMBLY

Thesis submitted in accordance with the partial requirements of the

Universiti Teknikal Malaysia Melaka for the

Bachelor of Manufacturing Engineering (Manufacturing Design)

By

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Author's Name	:	Azrin bin Maharani
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APPROVAL

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

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ABSTRACT

The title for this project is 'Design and Model Making of Hemming Jig for Car Door Assembly' where the student has to design and also making the model for a car door hemming jig. The project have covered chapter 1 (Introduction), chapter 2 (Literature Review), chapter 3 (Methodology), chapter 4 (Result and Analysis), chapter 5 (Discussion), chapter 6 (Conclusion) and lastly the chapter 7 (Suggestions and Recommendations). Introduction described about title selection, objectives, scope of project and problem statement. In chapter 2 has covered all of related findings through readings books, journal, article and searching internet. All of materials are gathered and recorded for further references in finding all the results. Besides, all of consideration in designing of hemming jig, its function, hemming process and tools that been used in this project were described in this chapter. Chapter 3 has described about methodology where stated a methods, procedure, technique and process flow to do this project. The software that been choose to be used in this project is CATIA where the factor of selecting this software because the software itself has several functions and criteria to design the hemming jig. Besides that, by using this software, data can be transfer to rapid prototyping machine for produce a model of hemming jig. Chapter 4 describes about the result and analysis that have done to complete the project. In this project also have covered all the process that been done to produce the model of the hemming jig. It covered the calculation that have done and some of the detail drawing of the design. For the chapter 5, it is about the discussion of the project where all the problems that occurred in completing the result. For the conclusion which is the sixth chapter, it about the conclusion and explanation of project itself weather it success or opposite by following the objective that been suggested by the supervisor. Lastly, the suggestions and recommendation covered how it supposes to do in the future for a better result and product.

ABSTRAK

Tajuk bagi projek ini merupakan Rekabentuk dan Membina Model bagi Aci Pelipat untuk Penggabungan Pintu Kereta di mana pelajar harus mereka bentuk dan juga membina model untuk aci pelipat bagi pintu sesebuah kereta. Projek ini meliputi bahagian 1 (Pendahuluan), bahagian 2 (Kajian Literatur), bahagian 3 (Metodologi), bahagian 4 (Keputusan dan Analisis), bahagian 5 (Diskusi), bahagian 6 (Kesimpulan) dan akhir sekali bahagian 7 (Cadangan). Pendahuluan menyatakan tentang pemilihan tajuk, objektif, skop projek dan juga masalah yang bakal timbul. Bahagian 2 pula adalah berkenaan pencarian melalui buku, risalah, artikel dan menggunakan jalur lebar. Hasilnya digabungkan dan direkod untuk rujukan akan datang. Selain itu, semua yang berkenaan dalam mereka bentuk aci pelipat, fungsinya, proses melipat dan juga alatan yang digunakan dalam projek ini diterangkan melalui bahagian ini. Bahagian 3 menerangkan tentang metodologi dimana mengandungi kaedah, cara kerja, teknik dan aliran proses untuk projek ini. Perisian yang dipilih dalam melaksanakan projek ini adalah CATIA dimana faktor pemilihan adalah kerana perisian ini mengandungi banyak fungsi dan kritiria untuk mereka bentuk aci pelipat. Selain itu, dengan menggunakan perisian ini, data yang diperoleh boleh dihantar kepada mesin pembuat prototaip pantas untuk membina model aci pelipat. Bahagian 4 menerangkan keputusan dan analisis yang diperolehi untuk menyiapkan projek ini. Dalam projek ini juga meliputi semua proses untuk membina moel aci pelipat. Ia juga meliputi tentang pengiraan dan lukisan terperinci bagi rekaan tersebut. Untuk bahagian 5, ia adalah tentang diskusi projek di mana semua masalah yang timbul untuk menyiapkan keputusan. Untuk kesimpulan iaitu bahagian keenam adalah tentang kesimpulan dan penerangan projek samaada ia berjaya atau tidak dengan mengikut kehendak objektif yang dicadangkan oleh penyelia. Akhir sekali, cadangan meliputi apa yang harus dilakukan pada masa akan datang untuk mendapat keputusan yang lebih baik dan juga produknya.

DEDICATION

To by beloved mother and father and also to all my friends especially to my special person, Ms. Noor Aswani bt Sulaiman.

ACKNOWLEDGEMENT

First of all, I want to thank to Allah SWT for giving me strength and wealthy to complete my Projek Sarjana Muda. Then, I also would like to thank my supervisor who gives me courage and guide to complete this project, my friends especially Mr. Mohammad Hafiz bin Basir who gave his permission for me to use his car as my refferences and also who either directly or indirectly helped me in this task. Thanks you very much.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The chapter 1 introduces about the general information with overall what a meaning this Final Year Project (Projek Sarjana Muda) subject. The objectives of this project is to train student working independently to design, produce, analyze, collect data and solving the problems using available facilities such as library, laboratory equipments, internet and software. Students also can improve their knowledge about engineering by apply their knowledge in science, mathematics and engineering subjects to solve the problems.

The title for this project is "Design and Model Making of Hemming Jig for Car Door Assembly" where student need to design a hemming jig to combine outer car door and the inner car door. This study will focus to design and develop a prototype of hemming jig that unavailable in market because this jig is built whenever car door assembly is needed.

To design this hemming jig, student use more on Computer Added Design (CAD) software named CATIA. Using this software, student also can make some analysis on hemming jig before transfer to Rapid Prototyping machine for mock up. The project will focus on designing the hemming jig included its force value that occur on the workpiece (inner and outer car door). Brief explanation of theory will be provided in the second chapter.

1.2 Problem Statements

Generally, this type of jig is only included in certain factory and strictly confidential to outsiders and this will bring a problem to imagine how the jig is look alike and how its functions. Therefore student need to contribute in visit to car manufacture company to take a look the hemming jig itself functioning. Although, within this limited of project period, student difficult to understand all the forces contributed, functions, visual and other properties. Some of them maybe had never been known by the student because it is very rare except for their own company employees.

Beside that, the force that occur on the hemming jig itself is difficult to calculate because of the angle of the force that changes when different process stage of hemming done. Some of the calculations are complicated and some of them must be valued as constant to make them simply to understand.

1.3 Objectives

The objectives of this project are:

i. To design a hemming jig.
ii. To calculate the forces that applies on the hemming jig.
iii. To develop a hemming jig model (rapid prototyping).

1.4 Scope of Project

The scopes of this project are:

i. Utilization of 3D modeling software in design and analysis.
ii. Utilization of rapid prototyping technology as a tool for mockup (model).

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Chapter 2 is a literature review for the design and development of hemming jig for car door assembly. In this chapter will introduce about the hemming jig and its functions. Introduction of hemming jig includes its definition and hemming stages. Besides, this chapter also describes detail about the hemming jig and the actual and prototype material used in manufacture industry. Some of the hemming device is design as hemming jig and also hemming die. The die itself included all the stages needed to hem two plates to hem together. By this project (hemming jig), it only needed to describe the detail about the jig that hold the car door (lower die) and it easier to understand rather than the hemming die.

2.2 Hemming Jig

2.2.1 Definition of Hemming Jig

Hemming is described as a process to fold down and stitch together between two materials (parts) and for the jig, it can be described as a device to hold workpiece. From these 2 definitions the hemming jig can be described as a device that hold workpiece when folding and stitching processes 2 materials is done. [9]

2.2.2 Introduction of Hemming

Hemming is used to connect two sheet metal components by folding the edge of an outer panel around an inner panel to create a smooth edge. Since hemming is the final stage of automotive forming operations, the defects introduced cannot be eliminated in the subsequent operations. Therefore, the hemming quality on the closure panels such as doors, hoods and deck lids has a great influence on the overall quality of a vehicle. Hemming represents the most severe case of 180° bending. It consists of three phases: flanging, pre-hemming and final hemming. According to the panel geometry, hemming can be classified into four categories: flat surface-straight edge hemming, flat surface-curved edge hemming, curved sur face-straight edge hemming and curved surface-curved edge hemming. In this project, only flat surface-straight edge hemming process is addressed. [2]

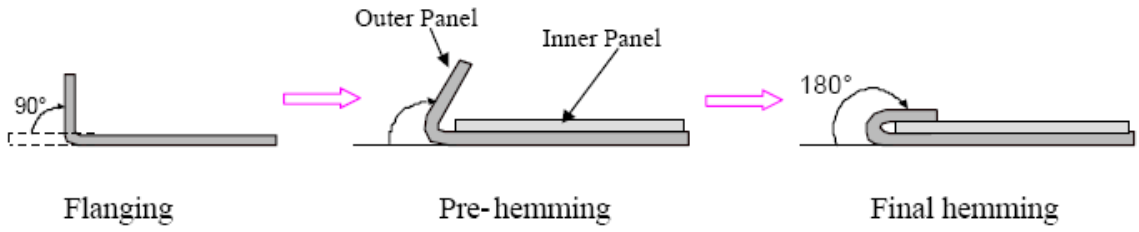

Figure 2.1: Phase in Hemming Process [2]

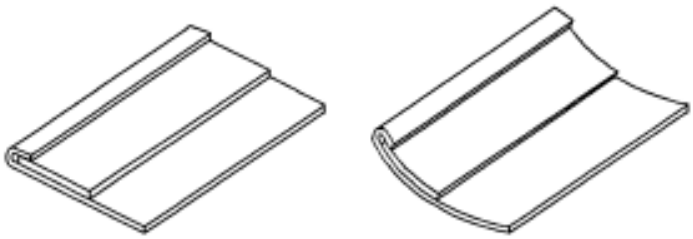

Figure 2.2: Two geometric representations of flat surface-straight edge hemming. [2]

2.2.3 Typical Hemming Quality

In the flat surface-straight edge hemming process, there are three typical hemming quality issues, creepage/growing, recoil/warp and springback. [2]

i. Creepage/growing

Creepage/growing is a kind of dimensional inaccuracy, which could cause problems in the assembly stage and influence the fitting quality. For example, the non-uniform clearance between a front door and a rear door is mostly caused by creepage/growing of the hemmed edge of the door panels.

ii. Recoil and warp

Recoil and warp are surface defects, which appear after final hemming springback. It was obtained to represent both recoil and warp. Final equivalent warp is the combined effect of recoil and warp.

iii. Springback

Sheet metal springback can influence the clamping force between the inner and outer panels. Springback occurring after pre-hemming and final hemming is illustrated in figure below. [2]

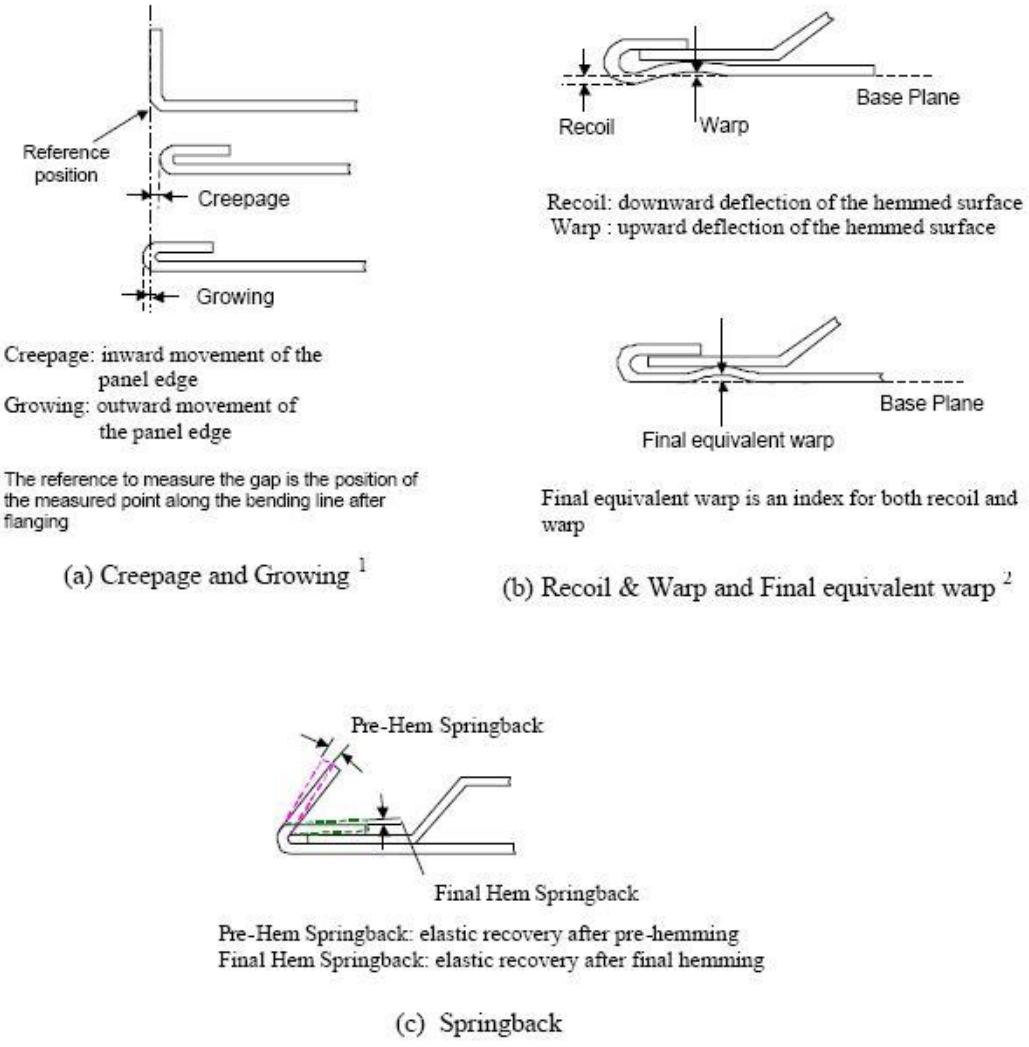

Figure 2.3: Typical Hemming Issues [2]

2.2.4 Hemming Geometry Controls and Factors

Geometry control of the sheet during pre-hemming and hemming operations is complicated, because the sheet is not supported by any other tool while being formed by the pre-hem and hem steels (upper dies). Thus, it is indirectly controlled by the following factors:

i. Sheet material properties and thickness.
ii. Hem edge geometry (straight, contoured etc.) and flange (hem) length.
iii. Previous deformation transferred from the stamping and flanging phases.
iv. Flange angle (after flanging and springback).
v. Pre-hem steel path and displacement (stroke).

vi. Pre-hem steel geometry (profile, face angle etc.).

vii. Frictional conditions.

viii. Influence of the additional support by the inner panel.

ix. Hem steel path (usually vertical or circular).

x. Maximum hem steel pressure (force) or final position. [4]

2.2.5 Phases of Hemming

2.2.5.1 Flanging

In this phase, each specimen is bent to approximately 90º using flanging die.

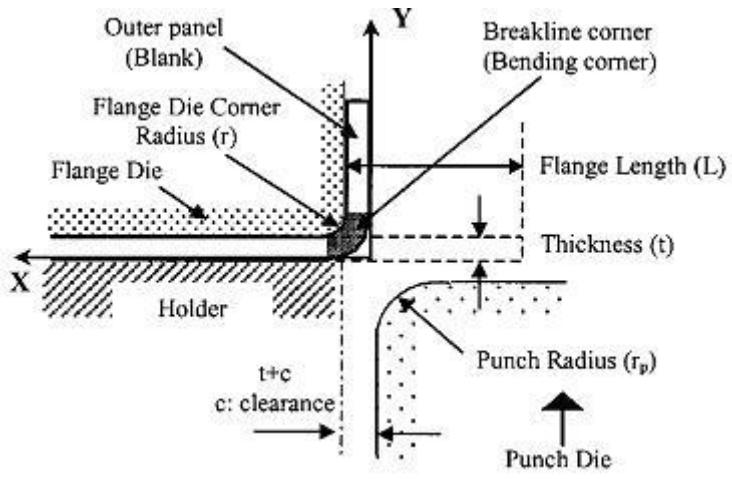

Figure 2.4: Flanging [1]

2.2.5.2 Pre-Hemming

The specimen that previously flanged to approximately 90º is pre-hemmed to approximately 45º (total rotation of 135º).

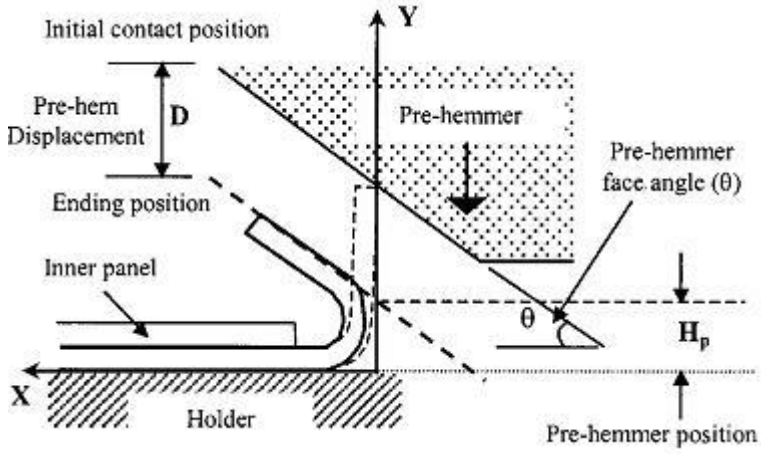

Figure 2.5: Pre-Hemming [1]

2.2.5.3 Final Hemming

The specimen then is hemmed by a hemmer that has parallel to the inner part until it bends 180º.

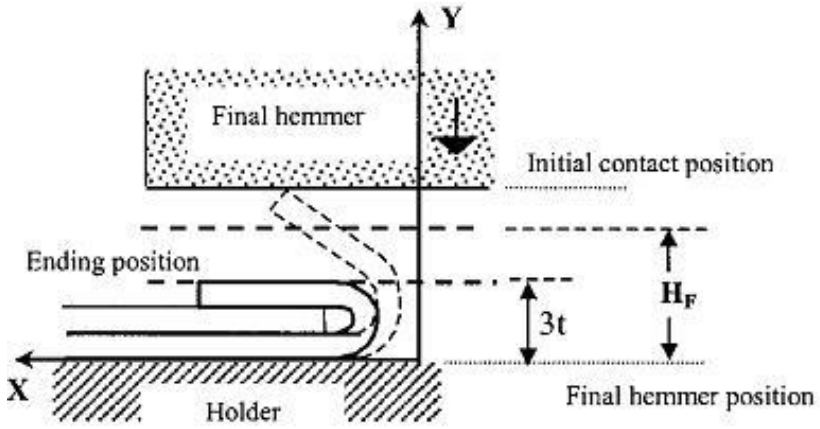

Figure 2.6: Final Hemming [1]

2.2.6 Hemming Process Sequence

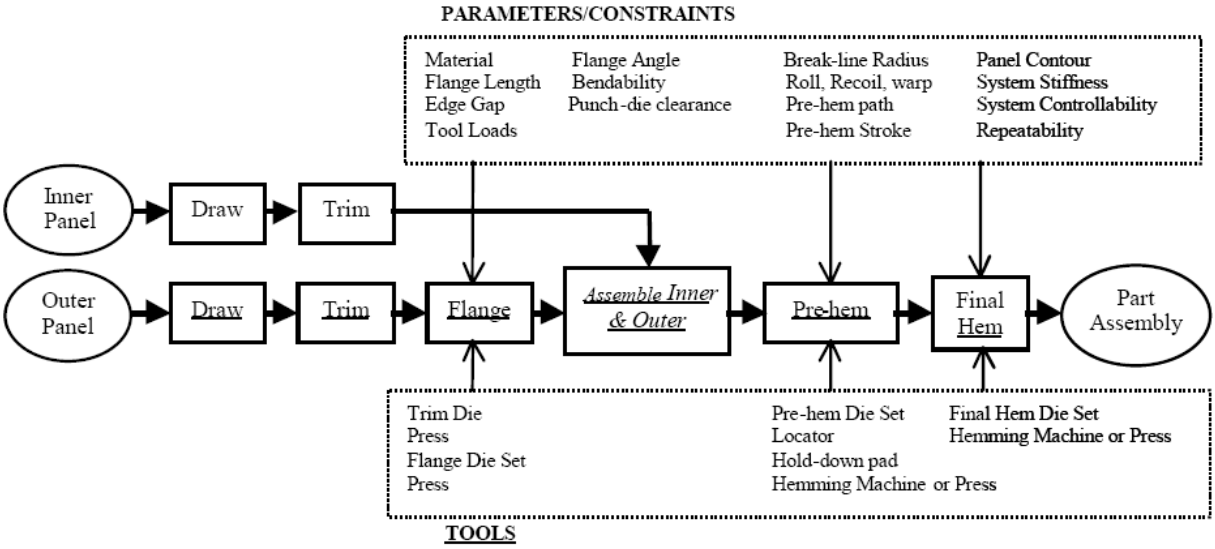

Figure 2.7: Process Sequence starting from trimming to final hemming operation. [3]

The figure above shows the IDEF-0 (Integration definition-Zero) model for automotive hemming. IDEF-0 model considers systems in terms of inputs, outputs, tools and constraints (parameters).

2.2.7 The Design Flow-chart proposed for the Hemming Process and Dies

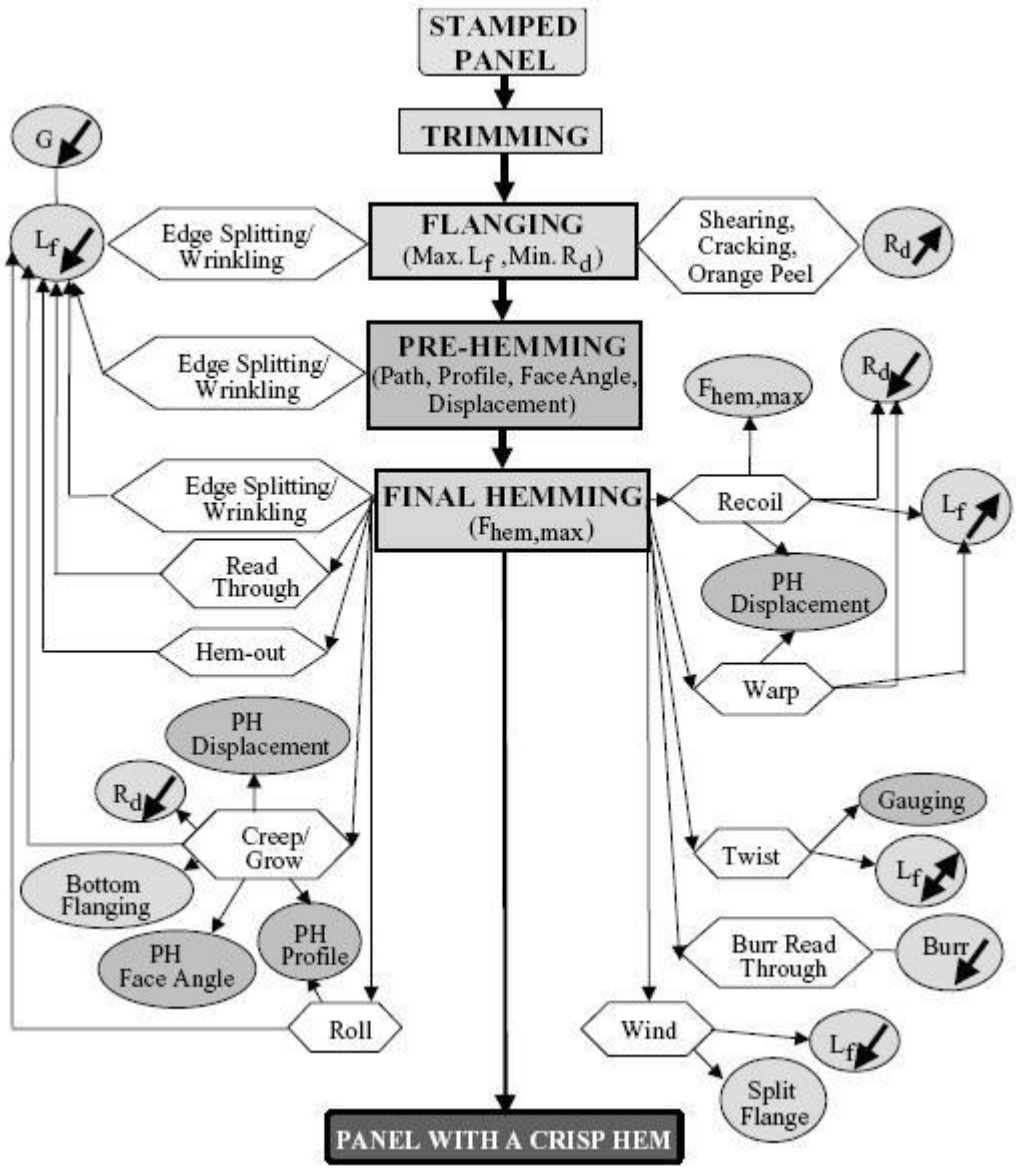

Figure 2.8: Design Flow-Chart proposed for the Hemming Process and Dies [3]

A design flow-chart for the current and optimized flanging as well as hemming process and tool design process have been summarized in figure above. The trends shown in the figure were compiled from the literature, from previous research and by discussing the topic with people from the industry. Such a flow-chart is useful in trouble-shooting during die