UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND ANALYSIS OF CASTING MOLD USING CAD TOOL

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) with Honours.

by

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FACULTY OF MANUFACTURING ENGINEERING

APRIL 2010

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SESI PENGAJIAN: 2009/10 Semester 2

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ABSTRACT

This project presents the design and analysis of casting mold using CAD Tool. The project basically investigated the design parameters for the casting mold and simulated the temperature and pressure on the mold. Turbocharger impeller was selected as the product of the study. Among the various types of casting techniques, investment casting process is the most suitable process to produce the turbocharger impeller. The alternative design of casting mold by investment casting was generated using CAD software. Concept scoring was prepared in order to select the suitable design for the investment casting process. Material selection of turbocharger is Aluminum Silicon Carbide. Stainless steel AISI H13 is selected as the material for the mold. The parameter for the mold design is included branch, gating, sprue and runner. Analysis was presented to the mold by using ANSYS simulation tool, in order to determine the temperature and pressure of the mold. In addition, three case studies were presented in order to compare the static pressure in different velocity and temperature of the mold design. The result showed the runner and the branch size were important to produce the molten metal flow into the mold pattern. As a result, the design of investment casting mold was proposed.

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ABSTRAK

Tajuk projek ini adalah Rekabentuk dan Analisis ke atas Acuan Tuangan Dengan Menggunakan Perisian *CAD*. Projek ini pada asasnya adalah bertujuan untuk mengkaji parameter tuangan acuan dan simulasi ke atas suhu dan tekanan acuan. Kompressor turbocharger dipilih sebagai produk teknik tuangan. Di antara jenis-jenis teknik tuangan, tuangan lilin hilang merupakan proses yang paling sesuai untuk menghasilkan produk tersebut. Alternatif rekabentuk acuan tuangan dihasilkan dengan menggunakan perisian *CAD*. Konsep penilaian dan penapisan telah disediakan untuk memilih rekean acuan yang paling sesuai untuk process tuangan lilin hilang. Pemilihan bahan untuk kompresor turbocharger ialah *Aluminum Silicon Cardbide*. *Stainless steel AISI H13* pula dipilih sebagai bahan kepada acuan tersebt. Parameter rekaan acuan tersebut termasuk cabang, sistem aliran, corong dan aliran. Analisis ke atas acuan itu telah dilakukan dengan menggunakan perisian *ANSYS* untuk menentukan suhu dan tekanan acuan tersebut. Sebagai penamabahan, tiga kajian kes dihasilkan untuk membandingkan tekanan statik pada halaju dan suhu yang berlain acuan tersebut. Keputusan menunjukkan aliran dan saiz cabang acuan adalah penting untuk menghasilkan aliran tuangan ke dalam acuan. Keputusannya, rekabentuk acuan tuangan lilin hilang dicadangkan.

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DEDICATION

This report is dedicated to my father and mother who have taught me that even the largest task can be accomplished if it is done step by step.

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LIST OF ABBREVIATIONS

AISI H13	-	Chromium-Molybdenum-Vanadium Alloyed Steel
CAD	-	Computer Aid Design
CFD	-	Computational Fluid Dynamics
CFX	-	Advanced Computational Fluid Dynamics
STL	-	Stereolithography
Utem	-	Universiti Teknikal Malaysia Melaka

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CHAPTER 1
INTRODUCTION

1.1 Background

There is various manufacturing process to produce parts which is including machining, casting, joining, forming and shaping. Among these manufacturing processes, metal casting is the most effective to produce metal parts. Metal casting processes include sand casting, plaster casting, investment casting and etc. Each of the process has its own characteristics and application to meet specific engineering and services requirement.

According to Kasim, e*t al*. (2008), manufacturing process selection is the task of choosing a method for transforming a set of material into a given shape using one or more processes. The material and manufacturing process selection problem is a multi-attribute decision-making problem. These decisions are made during the preliminary design stages in an environment characterized by and uncertain requirements, parameters, and relationships. Material and process selection decisions occur before design for manufacturing can begin.

According to Ravi and Datta (2004), metal casting has been mentioned in ancient Sanskrit texts such as *Shilpashastra* and *Yantra Sarvasva* and detailed in mediaeval texts such as *Shilparatna* and *Manasara*. The major application was in creating the idols used for worship; and very strict rules were laid down to achieve perfection in terms of *talmana* (proportions), *mudra* (stance) and *bhava* (expression). Other products included lamps, doors, frames, bells, cooking utensils, agricultural implements and weapons.

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According to Kalpakjian and Schmid (2006), metal casting technology was started before 4000 B.C. by using materials such as gold, copper and meteoric iron. Lost wax process which is known as investment casting was started around 4000 B.C to 3000 B.C. The technique of metal casting is keeping improved until nowadays to produce the best quality of metal product and to achieve public need and requirement.

For metal casting process, mold filling is the most important step in determining the quality of a casting. Surface quality, porosity caused by gas entrapment, misruns, micro segregation and mold erosion caused by strong metal streams. All these phenomena can be closely related to the mold filling condition. Therefore, mold life is also affected by mold filling. Although the solidification process appears to be of primary interest to the foundry engineer, solidification alone does not suffice for accurate prediction of casting quality refer to Attar *et al.* (2005).

A good design of mold will allow a smooth flow when filling. Therefore, mold design process is important to produce a better metal casting product. This study will carry out a casting mold design by using a CAD tool SolidWorks. The designation and the type of casting mold will be validated. The finite element analysis will be done on the mold. The analysis of heat transfer, temperature & pressure will be presented by using ANSYS. An automotive part, turbocharger impeller will be used as the product for the casting mold.

1.2 Problem Statement

As an automation part the turbocharger impeller is a very unique product. It needs sharp edge and strength to sustain it life. The angle of curvature at the inlet of curve inducer blades is hard to produce using machining technique. It is a time wasting if producing turbocharger impeller by using machining technique. Therefore, a sufficient technique is needed to produce this product with perfect quality and quantity. Metal casting is suitable for producing a metal product. To produce complex shape product with curve inducer blades, the type of metal casting process for the mold need to be determined.

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1.3 Objectives

The objectives of this project are:

a) To investigate the design parameters in designing casting mold.
b) To analyze the temperature and pressure in casting mold.
c) To propose a design of investment casting mold.

1.4 Scope and Key Assumption

This project presents the design of casting mold using CAD tools. SolidWorks is used to perform the details drawing of the mold. The analysis of temperature and pressure is presented by using simulation ANSYS. As a result, the design of investment casting mold is proposed. Stainless steel H13 is selected as the material of the mold.

1.5 Organization of the Report

The whole report is divided into six major parts, which is known as Introduction, Literature Review, Methodology, Results, Discussion, and Conclusion. Each chapter is briefly such as below:

a) Chapter 1: Introduction

This chapter briefly describes about the background of the study, problem statement, the objectives and scopes of the project. In the end of this chapter, it summarized the whole project and Gantt chart of the project will be shown at the end of this chapter.

b) Chapter 2: Literature Review

In this chapter, related information of the project is summarized. The literature reviews includes the introduction to technology of casting, selection of the casting mold type, material selection for the mold and tool selection for design the mold and

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to analysis it. The sources which are from journals, books, internet, articles and others are the guide to completing this project.

c) Chapter 3: Methodology

Methodology shows the flow of designing of the project. It starts from the problem analysis to the concept generation and concept selection and make the design decision. It is then following with the process of investment casting mold to produce the turbocharger.

d) Chapter 4: Results

In this chapter, the analysis of the mold is presented which is including temperature and pressure of the selected mold. At the end of the process, the design parameter is defined and an investment casting mold is proposed.

e) Chapter 5: Discussion

This chapter generally discusses on the result of the finding and implicate of the project. The finding is comparing to the objectives of the project whether it cover the scope of the study.

f) Chapter 6: Conclusion

At the end of the report, summarize of the project is make. Alternative suggestion or recommendation is given to improve in future study.

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1.7 Gantt Chart

Gantt chart is built to show the sequence of the project flow and activities. Figure 1.1 such as below shows the Gantt chart for PSM 1 which is briefly shows the time taken to finish the task in completing the project.

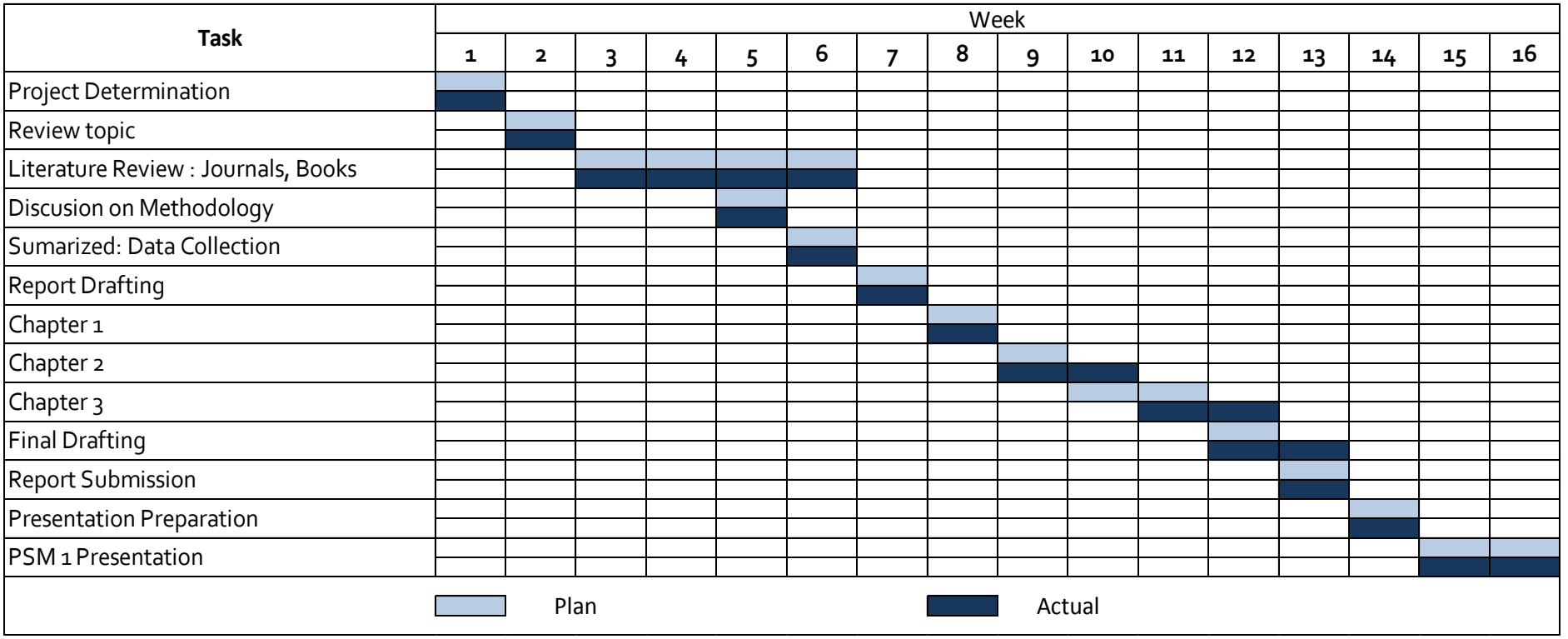

Figure 1.1: Gantt Chart of PSM 1.

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