UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND FABRICATION OF MARINE BOAT PROPELLER BLADE MOULD FOR INVESTMENT CASTING

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Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours

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DECLARATION

I declare that this Choose an item. entitled “Design And Fabrication Of Marine Boat Propeller Blade Mould For Investment Casting” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : Qalif

Name : QALIF BIN ISMAIL

Date : 25 June 2021

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.

Signature : 

Supervisor Name : TS. MUHAMMAD SYAFIK BIN JUMALI

Date : 25 June 2021

DEDICATION

Dedicated to

My honourable father, Ismail Bin Abd Rahaman

My precious mother, Limah Bt Sutan

My beloved brothers, Tasriq Bin Ismail,

Araaf Bin Ismail,

My beloved sisters Mujadilah Binti Ismail, Martiana Binti Ismail,

Izani Binti Ismail, Sajida Binti Ismail and Wahaiyu Binti Ismail

Thank you so much

ABSTRACT

The goal of this research is to design the mould for investment casting and investigate how the CATIA V5 software simulates the CAM process of a mould propeller blade by using the machining strategies such as multi-axis sweeping and multi-axis isoparametric by using the same parameter. Then, using a 5-axis milling machine, complete the fabrication. After that, investigate the impact of machining strategies on the surface roughness.The previous method of creating the propeller blade used machining, and the blade had some issues, such as the surface roughness not being smooth and insufficient dimensions. The previous method, which used a mold to create the pattern of the propulsion blade using wax before the investment casting process, was abandoned for this project.The type of material used for the mould is aluminium.

ABSTRAK

Matlamat penyelidikan ini adalah untuk mereka bentuk acuan untuk tuangan pelaburan dan menyiasat bagaimana perisian CATIA V5 mensimulasikan proses CAM bagi bilah kipas acuan dengan menggunakan strategi pemesinan seperti sapuan berbilang paksi dan isoparametrik berbilang paksi dengan menggunakan parameter yang sama. . Kemudian, menggunakan mesin pengilangan 5 paksi, selesaikan fabrikasi. Selepas itu, siasat kesan strategi pemesinan terhadap kekasaran permukaan. Kaedah sebelumnya untuk mencipta bilah kipas menggunakan pemesinan, dan bilah mempunyai beberapa masalah, seperti kekasaran permukaan tidak licin dan dimensi tidak mencukupi. Kaedah sebelumnya, yang menggunakan acuan untuk mencipta corak bilah pendorong menggunakan lilin sebelum proses tuangan pelaburan, telah ditinggalkan untuk projek ini. Jenis bahan yang digunakan untuk acuan ialah aluminium

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LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	Diameter
CNC	-	Computer Numerical Controlled
NAB	-	Nickel-Aluminium-Bronze
MAB	-	Manganese –Aluminium-Bronze
CAM	-	Computer Aided Manufacturing
CAD	-	Computer Aided Design
RPM	-	Revolution Per Minute
3D	-	3-Dimension
V	-	Cutting speed
N	-	Spindle speed
OA	-	Orthogonal array
Ra	-	Surface Roughness

LIST OF APPENDICES

Note:

CHAPTER 1

INTRODUCTION

1.1 Background

The marine boat is one of the vehicles used in the runaway area. This marine boat has various types and uses, such as the purpose of national defence army, cargo ship, transport services for passengers and personal use. It has difference sizes depending on its own use, from small size to large size.

After that, the marine boat has the main part of the propeller blade. The function of this propeller blade is to move the marine boat forwards and backwards. The propeller blade uses rotational movement or rotations on the blade, such as turning the screw. It causes the blade to generate a single power to push the boat when it is twisted. The propeller blade system is not only used transportation in the water, it is also used in other mediums as well as in the air such as aircraft.

This propeller look like a fan, and it has several types of blades in this industry, namely from a 3 propeller to a 4 blade propeller and the size of the blade. Each of these blade has its own distinct advantages, such as the purpose of increasing speed and providing maximum traction as well as smooth navigation. The marine propeller is an important component that can affect the performance of the ship. The choice of material should be the focus of marine propeller manufacturing because it must maintain the durability and be able to survive for an extended period of time. Among the material used are gray cast iron, carbon and low-alloy steels, chromium stainless steel, chromium-nickel stainless steel, manganese

bronze, nickel-manganese bronze, nickel-aluminium bronze, Naval brass etc. The common material used to make the blade is Nickel-Aluminium Bronze (NAB) because it has high toughness and erosion-corrosion resistance (Durganeeharika & Babu, 2015)..

1.2 Problem Statement

There are numbers of manufacturing method to produce propeller such as casting, machining and composite layup and has its own advantages. Each process and equipment must be provided to produce blades using casting or layup methods such as moulds, machines, furnaces, etc. CNC machining is the most advanced technology in the blade manufacturing process because it has high throughput potential, accuracy, and repeatability, but it has some issues when machining on small propeller blades because it can cause cracks and insufficient dimensions and takes longer time to complete one blade due to its complex shape and thin. Therefore, this study, will developed an investment casting mould to produce blades to speed up the machining process after the casting process is done. Next, the surface of the mould must be smooth so that the surface of the blade is beautiful and there is no need to do the machining process.

1.3 Research Objective

The objective of this project are:

i. Design mould core and cavity propeller blade for pattern investment casting.
ii. Fabricate and evaluate the difference of machining strategies sweeping and isoparametric on surface mould core and cavity using CATIA V5 software simulation and CNC milling DMU60e.
iii. To investigate the impact of machining strategies on the surface roughness between core and cavity.

1.4 Scope of Research

This study will be limited to this aspect:

i. Design mould core and cavity for propeller blade.

ii. Simulation using CATIA V5 software.

iii. Machining strategies

iv. Fabricate the mould of propeller blade

v. Surface roughness.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, we will cover the process of machining the mold casting for the Propeller Blade. Using 5-Axis CNC Milling and CATIA software to design the mold and generate code for machining. After that, to know the appropriate parameters to obtain a suitable surface for the mold.

2.2 Propeller Blade

The propeller whose name originates from the Latin word “propeller” which mean “to move forwards”. As a viable power source for the steam engine, an efficient screw propeller was developed at the beginning of the 19th century. Propellers are revolving duct fans that convert rotational motion into thrust which balances the resistance against move forward at that particular throttle speed. As a result, the engine’s revolution are producing a higher propulsion force at a lower rotational speed (Durganeeharika & Babu, 2015). The propeller are produce the propulsion of a ship at lower speeds while also reducing vibration over the tugs while operating at a constant water flow rate (Santhosh Babu & Padmanabhan, 2017). The forward and back surfaces of the air foil-shaped blade create a pressure differential, and a fluid such as air or water accelerates behind the blade (Prasanth, 2018). The most common propulsion on ships is a propeller, which imparts momentum to a fluid and generates a force to act on the ship. Bernoulli's principle and Newton's third law are used to drive a ship. The propeller's thrust is delivered to move the ship through a transmission

system that includes a rotating motion created by the main engine crank shaft, intermediate shaft and bearings, stern tube shaft and bearings, and ultimately the propeller itself (Durganeeharika & Babu, 2015). In terms of ship and torpedo performance, the marine propeller is regarded as a vital component. Majority in marine application, propellers manufacturing of Nickel-Aluminium-Bronze (NAB) are employed, because have a good corrosion resistance, high-yield strength, dependability and affordability (Prasanth, 2018).

2.3 Investment Casting

Investment casting is a popular process for producing titanium alloy and super alloy components with a near-net shape and numerous for investment casting, including wax injection, shell mould making, dewaxing, roasting and pouring (Yameng & Zhigang, 2018). According to Dhilawala (2017), they studied that, among the metallurgical arts, investment casting is both one of the oldest and most advanced and the rudiments of the investment casting method were employed by painters and sculptors in ancient Egypt and Mesopotamia to make elaborately designed jewellery, pectorals, and idols.

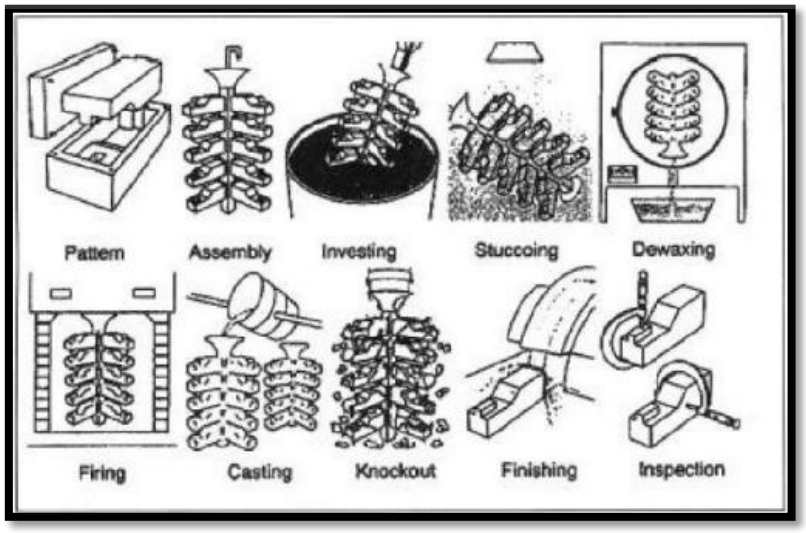

Figure 2.1Progress in Investment Casting (Dhilawala, 2017)

Figure 2.1 shows the progress in investment casting. The investment casting method proved useful for many military components, and it spread into numerous commercial and industrial uses where complex metal part were required throughout the post-war period, however, the technology remained largely unknown.

2.3.1 Shell Mould

In There are numerous processes of investment casting including wax injection, shell mould making, dewaxing, roasting and pouring (Yameng & Zhigang, 2018). Direct pouring into an investment casting shell mould using vacuum induction melting (VIM) because casting trees with a high yield can be manufactured quickly using a shell mound, it is an advantageous production process (Thomas et al., n.d.). According to Yameng & Zhigang (2018), they studied that one of the most important variable in keeping the casting process operating well is the shell's strength performance and with the popularity of investment casting in the aerospace industry, assessing the performance of ceramic shell moulds has become a research priority.

According to Harun et al (2015), they studied that the construction of a very thin ceramic shell mould is difficult because it necessitates many dipping processes in slurries including fine mesh refractory filler and a colloidal binder system. As a result of its origins in colloidal slurry loose particles, ceramic shell mould is extremely brittle and sensitive to breakage. The strength and integrity of the mould are very important factors in ensuring that the metal part has the proper dimensions.