UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND MACHINING OF AEROSPACE COMPONENT

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

By

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Design and Machining of Aerospace Component**

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I hereby, declared this report entitled "Design and Machining of Aerospace Component" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) (Hons.). The members of the supervisory isas follow:

………………………………

(Project Supervisor)

ABSTRACT

This final year project entitled "Design and Machining of Aerospace Component". The project is to improve the surface finish of machining from the aerospace component by getting the optimum cutting parameters. The component is fitting hinge of landing gear door which is used to join the landing gear door with strut on the aircraft. This problem is carried out based on the highlighted problems of aircraft component manufacturer by IMAI AEROSPACE COMPONENT (IAC) MALAYSIA. The problem occurred on the surface finish of the fitting hinge is rough surface finish. These problems occurred due to the unsuitable cutting parameters. To solve the problems, cutting parameter need to be improve. An experiment was conducted to study the effect of cutting parameter on the surface finish of the product. Surface roughness, surface integrity and material removal rate (MRR) was measured for machining performance evaluation. Based on the result, the significant finding of this study is the surface roughness more influenced by feed rate and cutting speed. These parameters play a very important role on forming surface roughness because surface roughness = 0.19µm can be improved when increase the spindle speed = 3250 rpm and reduce the feed rate = 1000mm/min.

ABSTRAK

Projek tahun akhir ini bertajuk "Design and Machining of Aerospace Component". Projek ini adalah untuk penambahbaikkan kemasan permukaan pemesinan pada komponen aeroangkasa dengan membuat penambah baikkan pada parameter pemotongan. Komponen tersebut adalah "fitting hinge" yang digunakan pada pintu roda pendaratan dimana ia digunakan untuk menyambungkan pintu roda pendaratan dengan topang pada pesawat. Masalah ini didapati daripada masalah yang diketengahkan oleh IMAI AEROSPACE COMPONENT (IAC) MALAYSIA. Masalah yang berlaku pada kemasan permukaan "fitting hinge" kemasan permukaan yang kasar. Masalah ini berlaku kerana parameter pemotongan yang tidak sesuai.Untuk mengatasi masalah tersebut, parameter pemotongan memerlukan penambahbaikkan. Eksperiment telah dijalankan untuk mengkaji kesan parameter pemotongan terhadap kemasan permukaan pada produk. Kekasaran permukaan, integrity permukaan dan kadar pembuangan bahan (MRR) telah diukur untuk penilaian prestasi pemesinan. Berdasarkan keputusan yang diperolehi, penemuan yang ketara dalam kajian ini adalah kekasaran permukaan adalah lebih berhubung kait dengan kelajuan spindal (spindle speed) dan kadar suapan (feed rate). Parameter tersebut memainkan peranan yang sangat penting dalam penghasilan kekasaran permukaan = 0.19µm kerana ia boleh diperbaiki dengan menambah kelajuan spindal= 3250rpm serta mengurangkan kadar suapan = 1000mm/min.

DEDICATION

Very thankful to Allah and special thanks to my beloved supervisor,
my friends, and
my beloved parent and family

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First of all, thanks to my bachelor degree final year project supervisor, Dato' Prof Dr. Abu bin Abdullah for his guide, help and support toward this project. With his advice, this project can be completed according to the plan.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Background

Manufacturing is concerned with making product. It is combination of processes to produce object that consist of numerous individual pieces. Manufactured product is also can be used to make other product like a drill is used for producing holes. There are two types of product such as discrete product and continuous product. Discrete product is an individual product such as bolts, nuts, and paper clips. Then, continuous product is a product which is cut into individual pieces for other process to create new product.

Manufactured item is start with raw material and following to the sequence of process to make a single product. Each new form of the material takes on gives it more use which is utility. The step of changing the form of material is done by a series of act called process. There are two major types of manufacturing process which are primary process and secondary process. Primary processing is the process to changes raw material into standard industrial stock. Raw material can be mineral ores, hydrocarbon liquid, plants, animal, or any of a number of basic material inputs. These raw materials are subjected to various primary processing activities.

All the output of primary processing is called industrial standard stock and it is needed to be further changes in form to be useful which is in the secondary processing. For secondary processing, it is a form of utility activity. It changes standard stock into useful finished products. The standard stock may be one of the basic major types of materials which are metals, polymers, or ceramic. After that, these materials are changed in shape, appearance, and internal properties through six types of secondary processing which are casting, forming, separating, conditioning, assembling and finishing. In addition, each of the six secondary process families is different and they have their own common elements to contribute in their own way to the form utility of the material.

In the aerospace industries, there are produce many part or aircraft. It is consist of fuselage, wings, flaps, ailerons, tail, engines and others. To design an aircraft, the important thing is find the optimal proportion of the weight of the aircraft and payload. Each component of the aircraft must be strong and stiff enough to withstand to the variety of situation which it has to operate.

Based on the project title is "Design and Machining of Aerospace Component (fitting hinge for landing gear door)". Fitting hinge for landing gear door is a component that used to join the landing gear door with the strut. Strut will connect to the hydraulic systems to pull up the fitting hinge and the same time will pull up the landing gear door too. Fitting hinge is important because it is hold the landing gear door. It is must be high strength to hold the heavy landing gear door to avoid the landing gear door drop to the ground. It is also influence to the smooth operation of the extent and retracts the landing gear door.

1.2 Problem Statement

Today the global aircraft traffic growth level is continuously growing fast in global scale. The expected number of airplanes in the world will increase at an average of 3.6 % per year by referring to the Figure 1.1 that can shows the estimation number of the aircraft in the world.

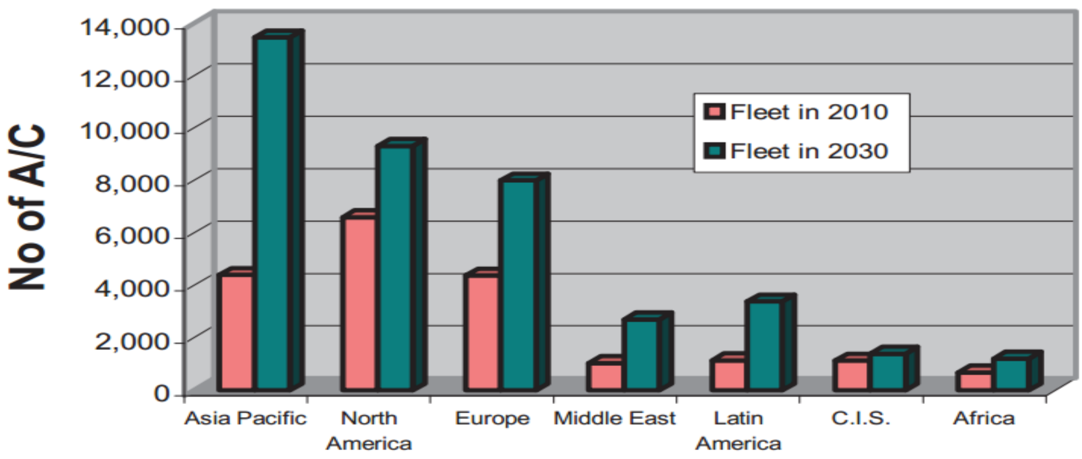


Figure 1.1: Aircraft fleet growth 2010-2030 (Gregor Kappmeyer, 2012)

Because of the increasing number of the aircraft, it will influence to the increasing of number of new components and spare part demands. In order to the current and future demands, the manufacturing sector had built up and developed more global supply chain to cope with the production numbers and quality standards to make sure the best deliveries of demands in the industry.

The machining of the aerospace component material is focused on the high stock removal rates in roughing processes and also in the high surface finishing rates and good surface finish and surface integrity in finish machining. The common problems that occur on the machined part surface are vibration mark, mismatch and over cutting. There are many factors that cause these entire problems happen such as the cutting parameters is not suitable for the machining process, cutter wear and also toolpath design.

In the other hands, future business requirements are considered. It is include on robustness of machining solutions and control of boundary conditions to be met and acceptable surface condition in machining. The key to achieve the overall quality and productivity goal is by using modern machine tool concepts, advance machining processes and methods.

1.3 Objectives

The aims of this project are:

1. To study the surface roughness of fitting hinge by changes the machining parameters.
    a) Spindle speed
    b) Feed rate
2. To study the surface integrity of high and low surface roughness after machined by different machining parameters.
3. To find the optimum machining parameters for the accepted surface roughness from 0 to 0.5 μm.

1.4 Scope

This project focused on the improving the surface finish of part by modification on the machining parameters in machining process by using CNC vertical machining centre. Machining parameters are including of feed rate, and spindle seed. The different surface roughness values will give different surface integrity. The surface roughness value is in the range of 0 to 0.5 μm for the accepted value of surface roughness.

CHAPTER 2
LITERATURE REVIEW

2.1 Aircraft Structural Component

The major aircraft structures are wings, fuselage, and empennage. The primary flight control surfaces, located on the wings and empennage, are ailerons, elevators, and rudder.

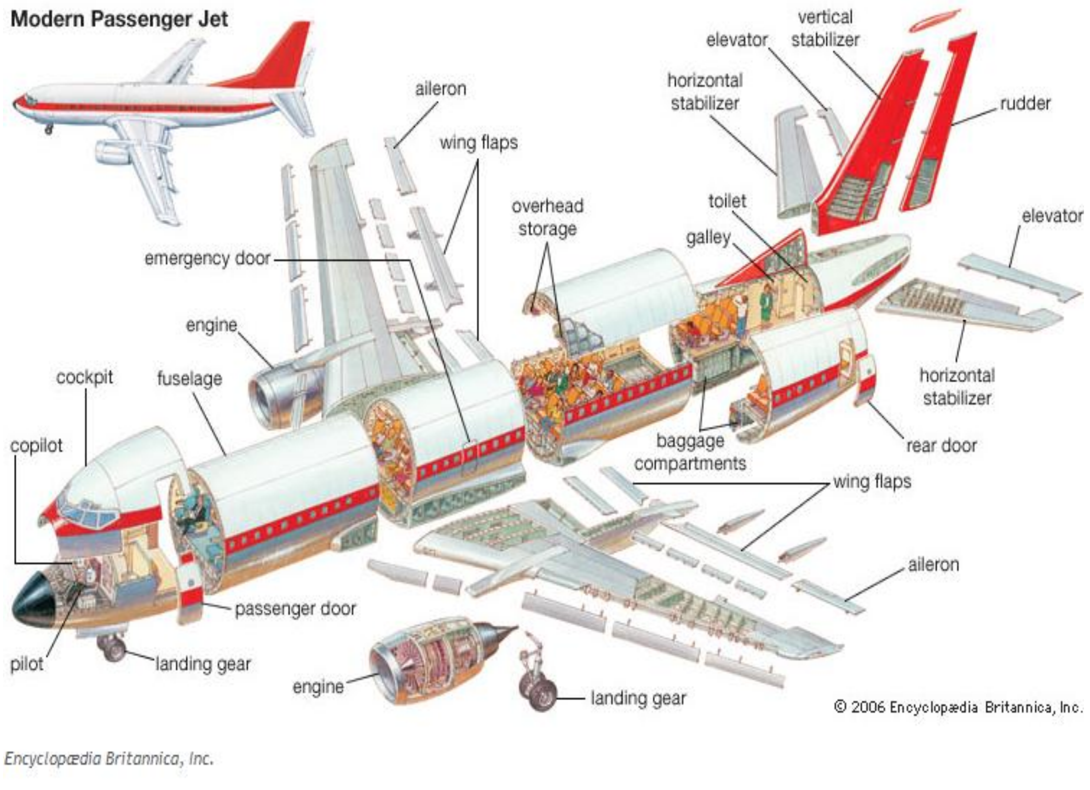


Figure 2.1: Part of an airplane (Encyclopedia Britannica, 2006)

2.1.1 Wings

Aircraft wings have to be strong enough to withstand the positive forces of flight as well as the negative forces of landing. Metal wings are of two types: Semicantilever and full cantilever. Semicantilever, or braced, wings are used on light aircraft. They are externally supported by struts or flying wires which connect the wing spar to the fuselage. A full cantilever wing is usually made of stronger metal. It requires no external bracing or support. The skin carries part of the wing stress. Parts common to both wing designs are spars, compression ribs, former ribs, stringers, stress plates, gussets. wing tips and wing skins (Routledge, 2010).

The principal structural parts of the wing are spars, ribs, and stringers. These are reinforced by trusses, I-beams, tubing, or other devices, including the skin. The wing ribs determine the shape and thickness of the wing (airfoil). In most modern airplanes, the fuel tanks either are an integral part of the wing´s structure, or consist of flexible containers mounted inside of the wing (Federal Aviation Administration, 2006).

Attached to the rear, or trailing, edges of the wings are two types of control surfaces referred to as ailerons and flaps. Ailerons extend from about the midpoint of each wing outward toward the tip and move in opposite directions to create aerodynamic forces that cause the airplane to roll. Flaps extend outward from the fuselage to near the midpoint of each wing. The flaps are normally flush with the wing´s surface during cruising flight. When extended, the flaps move simultaneously downward to increase the lifting force of the wing for takeoffs and landings (Federal Aviation Administration, 2006).

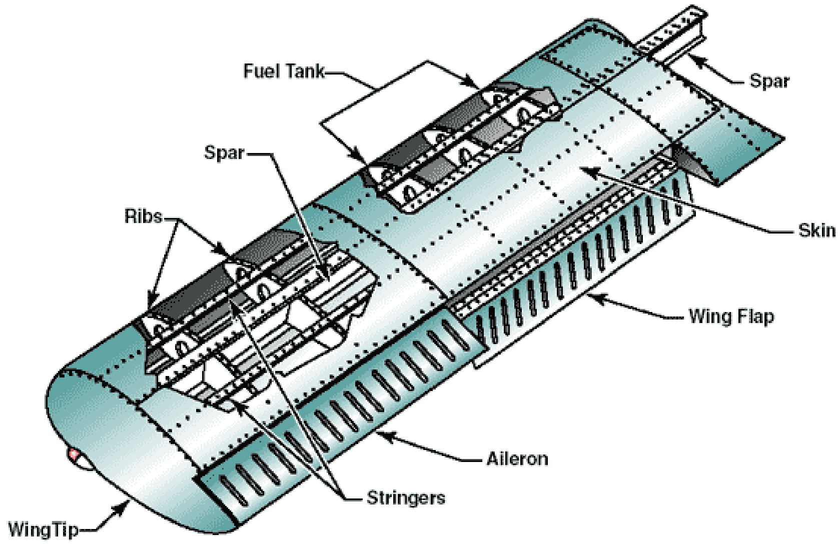


Figure 2.2: Wing components (Federal Aviation Administration, 2006)

2.1.2 Fuselage

The fuselage includes the cabin and/or cockpit, which contains seats for the occupants and the controls for the airplane. In addition, the fuselage may also provide room for cargo and attachment points for the other major airplane components. Some aircraft utilize an open truss structure. The truss-type fuselage is constructed of steel or aluminium tubing. Strength and rigidity is achieved by welding the tubing together into a series of triangular shapes, called trusses (U.S Federal Aviation Administration, 2006).

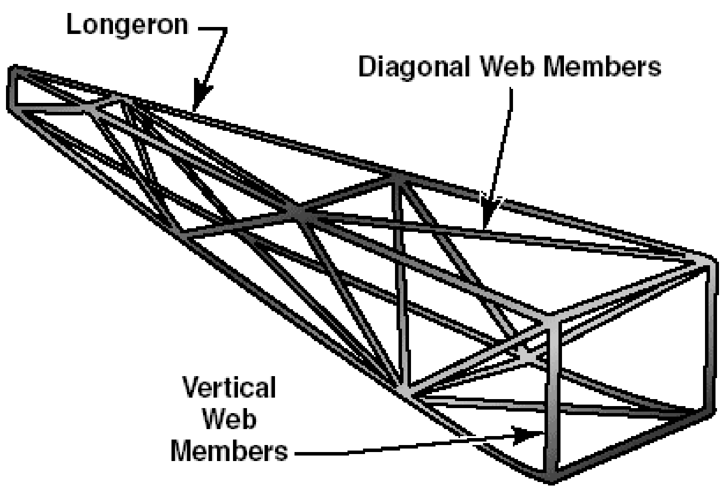
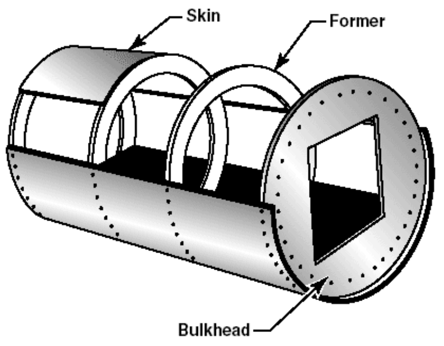
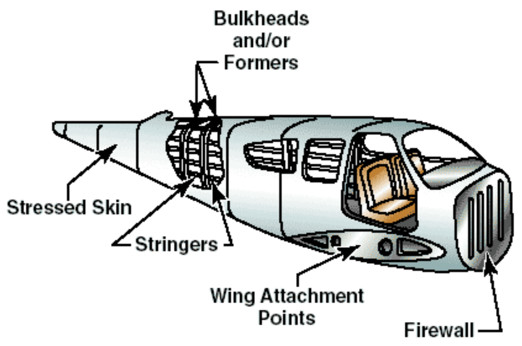


Figure 2.3: The warren truss (Private Pilot Ground School, 2006).

There are two types of metal aircraft fuselages: Full monocoque and semi-monocoque. The full monocoque fuselage has fewer internal parts and a more highly stressed skin than the semi-monocoque fuselage, which uses internal bracing to obtain its strength. The full monocoque fuselage is generally used on smaller aircraft, because the stressed skin eliminates the need for stringers, former rings, and other types of internal bracing, thus lightening the aircraft structure. The semi-monocoque fuselage derives its strength from the following internal parts: Bulkheads, longerons, keel beams, drag struts, body supports, former rings, and stringers (Routledge, 2010).

Table 2.1: Monocoque fuselage design and Semi-monocoque construction (Federal Aviation Administration, 2006)

a) Monocoque fuselage design	b) Semi-monocoque construction
	

2.1.3 Empennage

The empennage consists of the stabilizing fins mounted on the tail section of the fuselage. These include the vertical stabilizer on which is generally mounted the rudder that is used to control yaw, or direction of the nose about the vertical axis; and the horizontal stabilizer, on the trailing edge of which are the elevators that determine the pitch (climb or dive).Some supersonic aircraft may have a full delta wing. In that case, there is no horizontal stabilizer and the elevators and ailerons are combined into control surfaces called elevons.

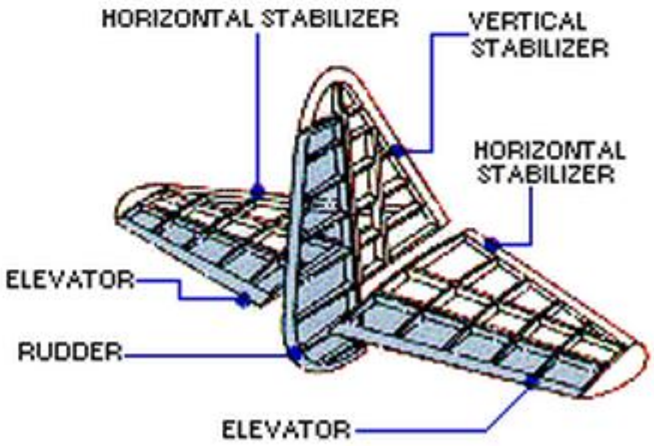


Figure 2.4: Empennage structure (Pilot Friend, 2012)

2.1.4 Power Plant

All modern, powered airplanes that do not use reciprocating engines as their source of thrust use some type of turbine engine. The word turbine means whirl and refers to any type of wheel device that has vanes attached to it in a manner that will cause the wheel to turn as the vanes are struck by the force of a moving fluid. Remember, air is a fluid. The turbine principle is also used to generate electricity by flowing water striking a turbine that is linked to a generator. Another method of generating electricity is to direct high-pressure steam against a turbine which is linked to a generator (All Star, 2008).

Turbine engines found in aircraft use the force of hot, flowing gases striking a turbine.. The turbine engine has also found widespread use as the source of power for military and civilian helicopters. In helicopters, the turbine is linked by gears to the helicopter's rotors in a manner that can be compared to the turbine-driven propellers for airplanes (All Star, 2008).

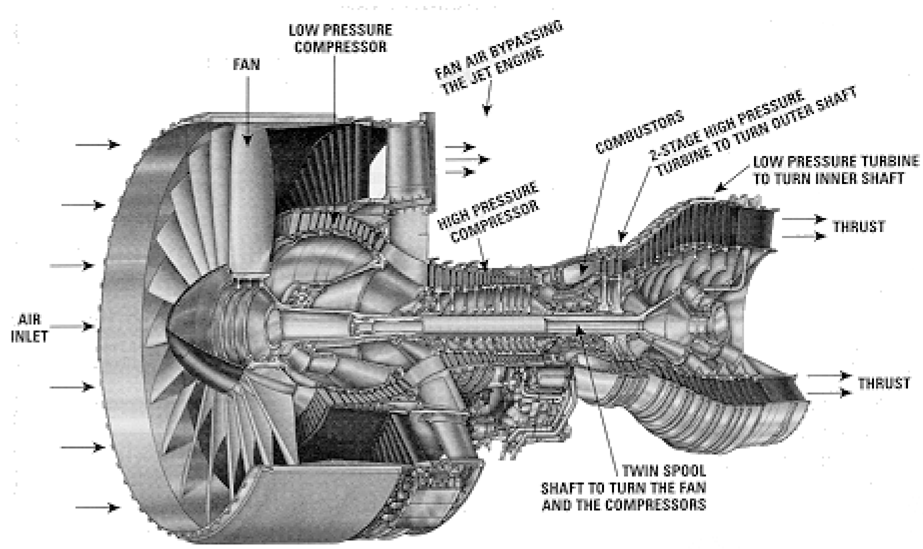


Figure 2.5: Aircraft Engine (AllStar, 2008)

2.1.5 Landing Gear

The landing gear is the principal support of the airplane when parked, taxiing, taking off, or when landing. The most common type of landing gear consists of wheels, but airplanes can also be equipped with floats for water operations, or skis for landing on snow (Federal Aviation Administration, 2006). The landing gear system on the orbiter is a conventional aircraft tricycle configuration consisting of a nose landing gear and a left and right main landing gear. Each landing gear includes a shock strut with two wheel and tire assemblies. Each main landing gear wheel is equipped with a brake assembly with anti-skid protection. The nose landing gear is steerable. The nose landing gear is located in the lower forward fuselage, and the main landing gear is located in the lower left and right wing area adjacent to the mid-fuselage.