

# Design and Fabrication of a Fighter Aircraft with Yawing Wing

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**ABSTRACT:** The main objective of this paper is to produce the Yawing action of the Fighter Aircrafts without the help of a Rudder. Thus, the drag induced due to Rudder and weight of the aircraft are reduced, thereby increasing the maneuverability of the Fighter Aircrafts. Therefore, Yawing of the aircraft, which does not have a Rudder, is carried out with the Yawing wings. The Yawing wings are those wings which can change their swept angle on the pilot's command when it is necessary to yaw the aircraft. If the aircraft is to be yawed to the right side direction, the swept angle of the right side yawing wing is increased. Similarly, if the aircraft is to be yawed to the left side direction, the swept angle of the left yawing wing is increased. Hence, the Yawing wings decide the Direction of Yawing of the Aircraft. The Yawing Wings are controlled by the Usual Hydraulic system of the aircraft. Hence, in order to verify the concept of yawing the aircraft using the yawing wing, the Unmanned Aerial Vehicle (UAV) is used. The fabricated unmanned aerial vehicle (UAV) is experimented for yawing the aircraft by using the yawing wing. Thus, this paper gives a new idea of designing the Fighter Aircrafts with increased maneuverability using Yawing Wings.

**KEYWORDS:** Fighter Aircraft, Rudder elimination, Drag reduction, increased maneuverability Yawing Wings, UAV Fabrication.

## I.INTRODUCTION

A fighter aircraft is a military aircraft designed primarily for air-to-air combat against other aircraft, as opposed to bombers and attack aircraft, whose main mission is to attack ground targets. The importance of a fighter aircraft are its speed, maneuverability, and small size relative to other combat aircraft. Most of the fighter aircrafts are supersonic in nature. The supersonic aircraft is an aircraft which can fly above the speed of the sound (Mach number above 1). Fighter and Attack aircrafts are the most important ones in the sphere of military power because of their design, speed, maneuverability and weaponry. The role of fighter aircrafts is to establish air superiority over a battlefield for that it requires high speed, increased maneuverability, and reduced weight and less Radar detectability.

### Problems Encountered In Fighter Aircrafts

The fighter aircrafts needs a very high maneuverability to establish its dominance. But, in modern fighter aircrafts, huge amount of drag is produced. Also, because of the heavier control surfaces, aircraft's weight also increased. This in turn, leads to a poor performance of Fighter Aircrafts. Also, because of the huge control surfaces, the aircraft size increases and it becomes large enough to capture in Radars. Hence, there is a need in reducing the drag induced in the aircraft to achieve high maneuverability in the various flight regimes. But the main objective of fighter and attack aircrafts is to avoid Radar detectability.

### Proposed Concept

The main objective of this paper is to design a fighter aircraft with more superior qualities. In order to overcome the various problems encountered in Fighter Aircrafts, it is necessary to avoid any of the component that will have a greater effect in reduction of drag. In case of removing any component or control surface, the alter way of replacing that should be made. Probably, removing any control surface would reduce the drag induced in the aircraft but simultaneously it causes other flight control difficulties. Therefore, it must be ensure there is no control or other difficulties occurred while eliminating any of the control surfaces. Hence we introduce a new concept of removing the

control surface Rudder and avoid the form drag and skin friction drag induced in it. Simultaneously, the function of the rudder is to be performed with the existing aircraft component such as wing with a modification in it. The Modified wing is known as the Yawing wing. This proposal has been developed based on a comprehensive literature review. As far as the literature review is concerned, most of the research presidencies were related with the reduction of aerodynamic drag by the way of suggesting Morphing wings or involving the design of Flying Wings or with the design of Tailless Aircrafts. Though the literature review conducted in this research is not an exhaustive, it came to notice that none of research attempts have been made in producing the Yawing Control in the Fighter Aircrafts with the help of Yawing Wings.

## II. PROPOSED WING DESIGN METHODOLOGY

The yawing wing is a modified general aircraft wing that is to be used for the fighter aircrafts. The Yawing wings have the mechanism of increasing the Sweep angle in order to yaw the aircraft.

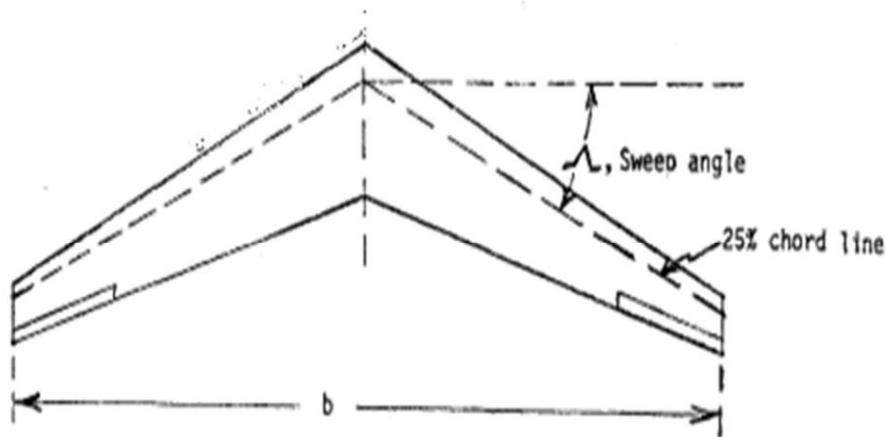


Figure 1: Sweep angle determination in Swept Wings

The sweep angle is normally calculated by drawing a line from root to tip 25% of the way back from the leading edge of the wing, and that to the perpendicular to the longitudinal axis of the aircraft. The typical measurement of Sweep Angle is shown in figure 1. Usually the sweep angle varies from  $0^{\circ}$  to a maximum of  $45^{\circ}$  or even more. Usually for fighter and supersonic speed aircrafts, Swept wings especially Swept Back wings are preferred because of its greater performance at high speeds.

### Mechanism of Yawing Wing:

The yawing wings are connected to the usual hydraulic system of the aircraft. The direction of the aircraft can be changed by varying the swept angle of the wing. If the swept angle of the right side wing is increased, the aircraft yaws to the right direction. Similarly, if the swept angle of the left side wing is increased, the aircraft yaws to the left direction.

### Design of the Proposed Model

The suggested new idea of yawing the aircraft using the Yawing Wing is to be implemented for the fighter aircrafts. If it is implemented, the maneuverability will be increased, and subsequently it reduces the weight and drag induced in the aircraft. Also, by removing the rudder, the size of the vertical stabilizer is also reduced. But, manufacturing a fighter aircraft looks very cost effective. Hence, in order to verify the concept of yawing the aircraft using the yawing wing,

the Unmanned Aerial Vehicle (UAV) is used. Thus in this proposal, a fabrication of UAV with the proposed concept is done to prove the yawing motion of the aircrafts using Yawing Wings.

**III. FABRICATION METHODOLOGY**

**Dimension of the Geometry**

The fabricated unmanned aerial vehicle which describes the concept of yawing wing is fabricated with the above dimensions. The dimensions are referred from the reference fighter aircraft F111. The chosen reference dimensions are shown in figure 2.

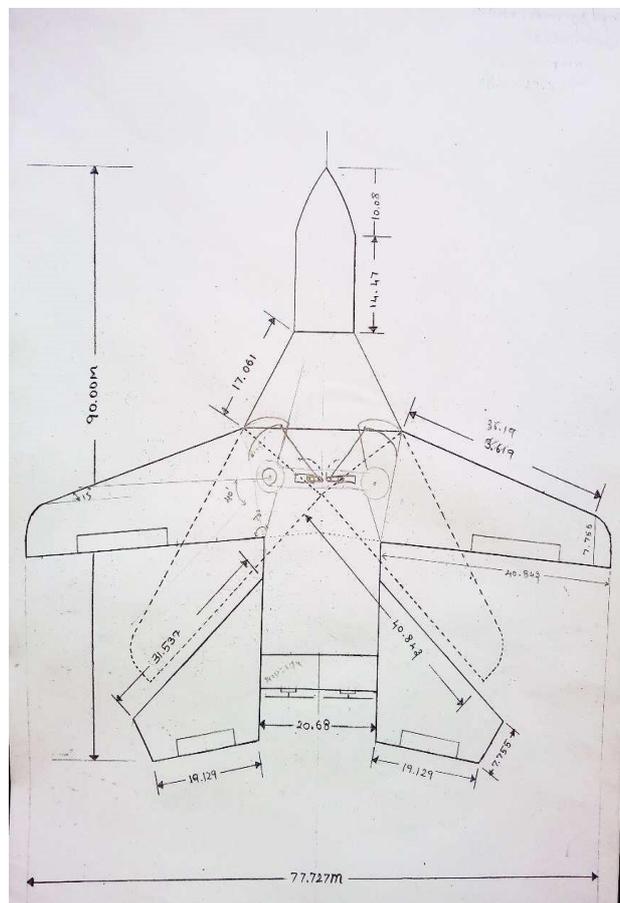


Figure 2: Dimensions for the Fabricated Model UAV

**Materials and Electrical Components Collected**

The materials required and the various electrical components needed for the fabrication of proposed Unmanned Aerial Vehicle (UAV) are collected. The following materials are to be collected in order to fabricate the unmanned aerial vehicle to describe the Yawing Wing concept that can be used in Fighter Aircrafts. **Materials Required**

- Thermocol with high density
- Propeller- 10 inch
- Balsa wood and ply wood
- Insulation tape.
- Steel windings.
- Landing gear.

**Electrical Components Required**

- Brushless Motor (1000kv) - 1
- Electronic speed control (ESC) - 1
- Servo Motor - 4
- Li-Po Battery (2200mAh) - 1
- Transmitter and Receiver - 1

**Fabrication of Yawing Wing**

The required measurements are marked in the thermocol and taken out as separate pieces. The upper surface of the thermocol is smoothed in order to obtain the airfoil shape. Then, those pieces are covered with the insulation tape. This work is done and the initial stage of this Fabrication work is shown in figure 3.



Figure 3: Initial Stage of Wing Fabrication

Care is taken that no air bubbles struck in between the covered surfaces. The airfoil type preferred here is Symmetrical Airfoil since the Unmanned Aerial Vehicle (UAV) is more effective with the symmetrical type of airfoils. Then, the insulated thermocol is folded and the trailing edge of the fabricated wing is fixed using gum. The wing attachment is made with the help of Balsa wood and Ply wood and the linkages are done by using bolts and nuts. This work process is shown in figure 4 and 5.

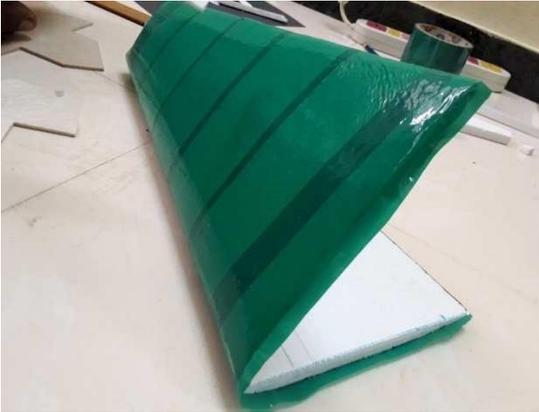


Figure 4: Folding to obtain Airfoil shape

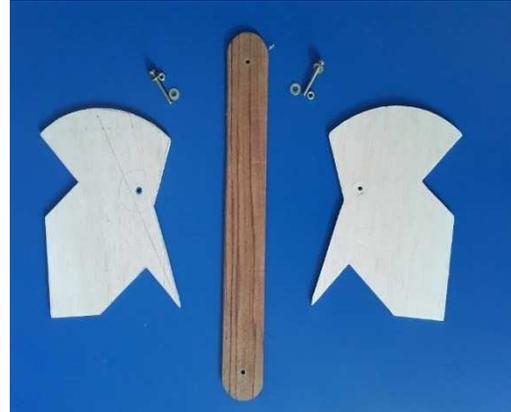


Figure 5: Requirements for Wing attachments The right and left wing of the aircraft is first attached to the balsa wood which is connected to the fuselage body by means of a plywood. Finally, the two wings- left wing and right wing are fabricated and is shown in figure 6.

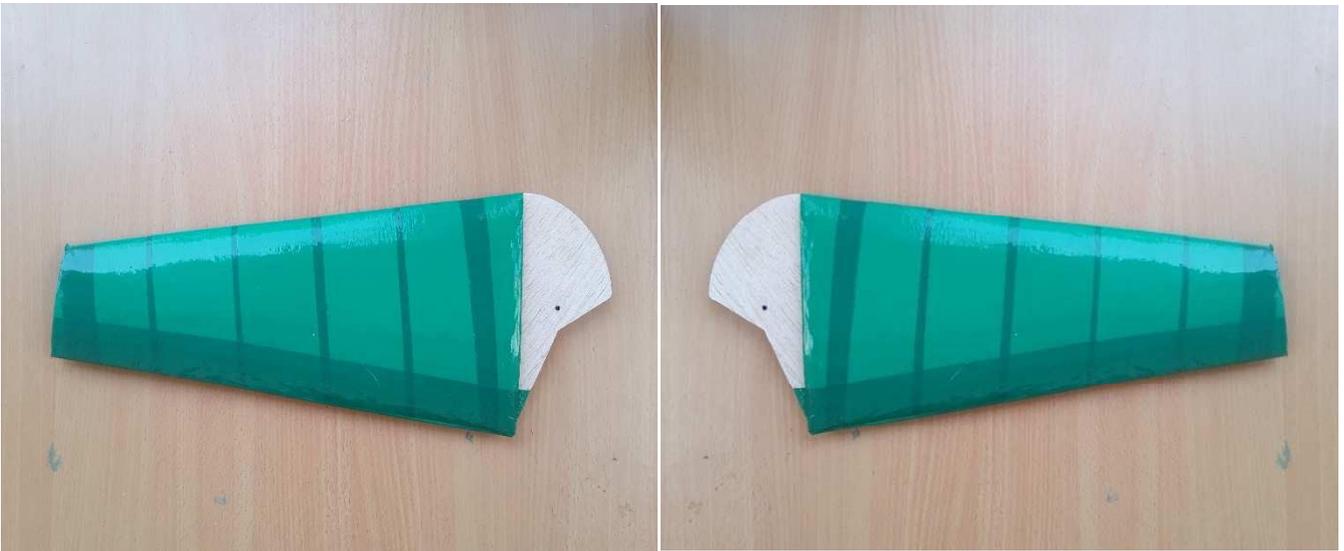


Figure 6: Left Wing and Right Wing

The yawing wing is attached to the fuselage with the bolt and nut using the Balsa wood. The shape of the balsa wood and the attachment is shown in the figure 7.



Figure 7: Wings ready to attach with fuselage section

#### **Fabrication of Nose and Fuselage**

The fuselage and the nose section is made as per the required dimensions. The wing is attached to the fuselage as mid wing configuration. The parts of the fuselage and the nose are smoothed without any sharp edges. The individual pieces of the fuselage and nose are attached to each other using glue gun. The wing is attached to the fuselage as a midwing. The landing gear is attached to the fuselage and nose using bolt and nut.

In order to strengthen the fixing wood is used in between the washer and thermocol. The assembly of Wings with Fuselage and Nose section is shown in figure 8.



Figure 8: Wings attached with Fuselage and Nose section

#### Alignment of Electrical Components



Figure 8: Alignment of electrical components

The two servo motors are placed for the operation of changing the swept angle of yawing wing. Similarly, two individual servo motors are used to control the elevator. The Electronic speed control (ESC) is connected in series with the brushless motor and receiver. Simultaneously the battery is also connected to the Electronic speed control (ESC) to

supply the powers. Servo motors receive their power supply and command signals from the receiver. The battery and the receiver is placed in the nose of the unmanned aerial vehicle. The various alignment and connections of electrical components with servo motor and elevator linkages are shown in figures 8 and 9.



Figure 9: Servo motor and Elevator linkages



Figure 10: Fabricated Unmanned Aerial Vehicle

The fabricated model of the Unmanned Aerial Vehicle which implies the concept of using Yawing Wing in the Fighter Aircrafts is shown in the figure 10.

#### **IV. CONCLUSION**

Finally, the new idea of yawing the aircraft using a yawing wing is proved successfully using the Unmanned Aerial Vehicle (UAV). The fabricated Unmanned Aerial Vehicle is experimented for yawing the aircraft by using the yawing wing. As a result it is observed that the Unmanned Aerial Vehicle yawed to the right side direction when the swept angle of the right side wing is increased and yawed to the left side direction when the swept angle of the left side wing is increased.

Hence, this present paper serves as a pathway to step into the new era in Fighter Aircraft designs.

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