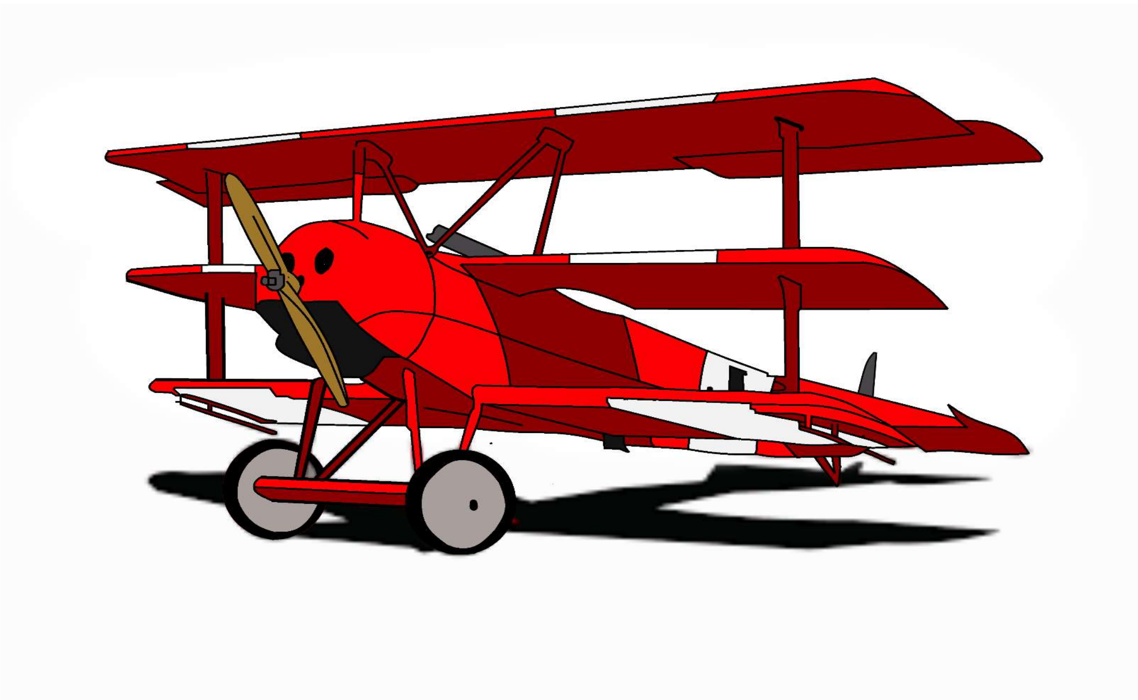
Physics Project

Automated Airplane

|Tejas Sastry | Shashank Noubade |11 A | 2018-19



Name of Experiment:	Automated Airplane
Presented by	Tejas Sastry, Shashank Noubade

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Certificate of Completion

This is to certify that this project entitled " Automated Airplane " is a bonafide mark carried by ______________________________ during the academic year 2018-19. This project has been approved as it satisfies the academic requirements with respect to the project work prescribed for class XI by the Central Board of Secondary Education.

Name of Student:

Internal Examiner:

External Examiner:

Date of Examination:

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Acknowledgement

We would like to express my special thanks of gratitude to our teacher Mr Rana Pratap as well as our principal Ms Malathy who gave us the golden opportunity to do this wonderful project on the topic Aero Dynamics which also helped us in doing a lot of Research and we came to know about so many new things .We are really thankful to them. Secondly, we would also like to thank friends who helped us a lot in finalizing this project within the limited time frame

Abstract

This report provides a thorough description of the design of a Automated airplane made by and Tejas Sastry Shashank Noubade of class 11A of National Public School, Rajajinagar during the academic year 2018-2019. It begins with research into aerodynamics, a brief study of motion of air, particularly interaction with a solid object. A study on the materials available to build the airplane is also carried out to ensure the airplane can withstand the stress and safety of people using it. This report not only covers the airplane design but also documents its construction.

Introduction

Have you ever wondered how Aeroplanes fly? We take for it granted that we can fly from one side of the world to the other in a matter of hours, but a century ago this amazing ability to race through the air had only just been discovered. What would the Wright brothers—the pioneers of powered flight—make of an age in which something like 100,000 planes take to the sky each day alone? They'd be amazed, of course, and delighted too. Thanks to their successful experiments with powered flight, the airplane is rightfully recognized as one of the greatest inventions of all time. Let's take a closer look at how it works!

Objective

In this project we aim to build a working airplane using simple building materials and building techniques. In the course of our experiment, we aim to explore new concepts and technologies that make aviation possible. We also explore the possibility of electric powered planes, understand the challenges, possibilities and limitations to this technology.

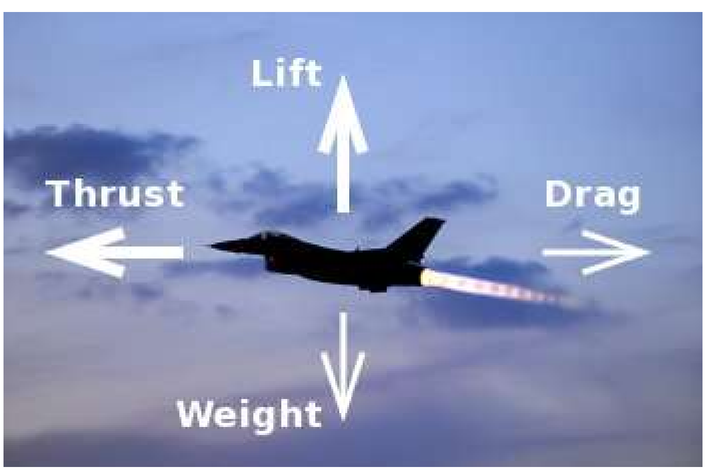
Materials

Item	Quantity
Depron foam	1.5m^2
Retractable knives	5
Hot glue	300g
2.4ghz radio	1 unit(transmitter and receiver)
9g servos	2 servos
Pushrods (rods made with metal with very high shear modulus)	2
Control horns	2
Cellophane tape	50cm
30Apms ESC(Electronic Speed Controller)	1
9.5”2 blade propeller	1
2400rpm/v Brushless dc motor	1

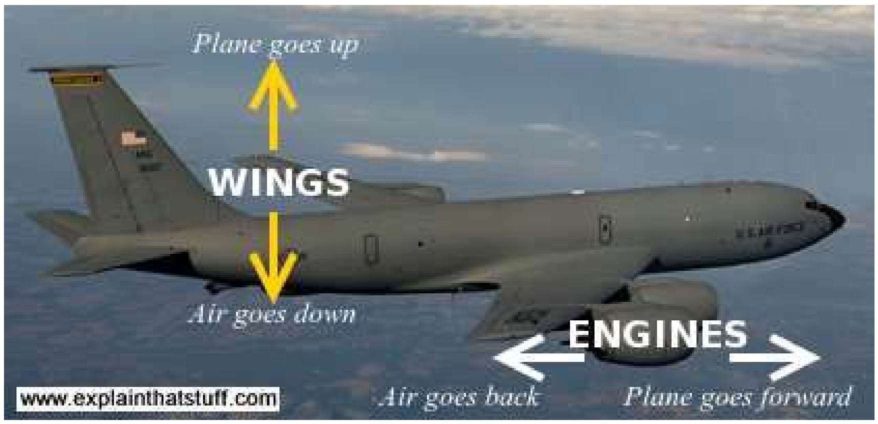
Theory:

How do planes fly?

If you've ever watched a jet plane taking off or coming in to land, the first thing you'll have noticed is the noise of the engines.Jet engines, which are long metal tubes burning a continuous rush of fuel and air, are far noisier (and far more powerful) than traditional propeller engines. You might think engines are the key to making a plane fly, but you'd be wrong. Things can fly quite happily without engines, as gliders (planes with no engines), paper planes, and indeed gliding birds readily show us. Four forces act on a plane in flight. When the plane flies horizontally at a steady speed, lift from the wings exactly balances the plane's weight and the thrust exactly balances the drag. However, during takeoff, or when the plane is attempting to climb in the sky (as shown here), the thrust from the engines pushing the plane forward exceeds the drag (air resistance) pulling it back. This creates a lift force, greater than the plane's weight, which powers the plane higher into the sky.



Newton's third law of motion *explains how the engines and wings work together to make a plane move through the sky. The force of the hot exhaust gas shooting backward from the jet engine pushes the plane forward. That creates a moving current of air over the wings. The wings force the air downward and that pushes the plane upward.*

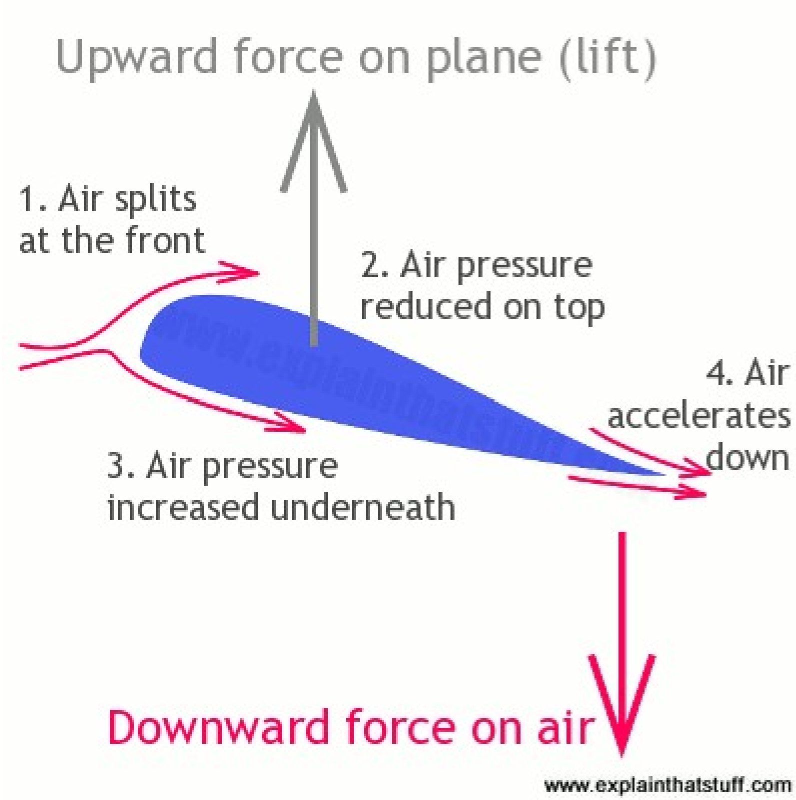


How do wings make lift?

In one sentence, wings make lift by changing the direction and pressure of the air that crashes into them as the engines shoot them through the sky.

Pressure differences

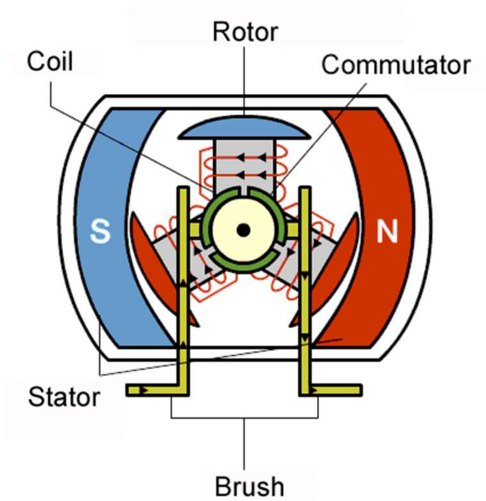
Okay, so the wings are the key to making something fly—but how do they work? Most airplane wings have a curved upper surface and a flatter lower surface, making a cross-sectional shape called an airfoil. It works on the principle of aerodynamics called Bernoulli's law, fast-moving air is at lower pressure than slow-moving air, so the pressure above the wing is lower than the pressure below, and this creates the lift that powers the plane upward.



As a curved airfoil wing flies through the sky, it deflects air and alters the air pressure above and below it. As a plane flies forward, the curved upper part of the wing lowers the air pressure directly above it, so it moves upward. As air flows over the curved upper surface, its natural inclination is to move in a straight line, but the curve of the wing pulls it around and back down. For this reason, the air is effectively stretched out into a bigger volume—the same number of air molecules forced to occupy more space—and this is what lowers its pressure. For exactly the opposite reason, the pressure of the air under the wing increases: the advancing wing squashes the air molecules in front of it into a smaller space. The difference in air pressure between the upper and lower surfaces *causes* a big difference in air speed. The difference in speed (observed in actual wind tunnel experiments) is much bigger than you'd predict from the simple (equal transit) theory. So if our two air molecules separate at the front, the one going over the top arrives at the tail end of the wing much faster than the one going under the bottom. No matter when they arrive, both of those molecules will be speeding *downward*—and this helps to produce lift in a second important way.

Brushless DC Motors

A motor converts supplied electrical energy into mechanical energy. Various types of motors are in common use. Among these, brushless DC motors (BLDC) feature high efficiency and excellent controllability, and are widely used in many applications. The BLDC motor has power-saving advantages relative to other motor types. In this type of motor, electrical current is passed through coils that are arranged within a fixed magnetic field. The current generates magnetic fields in the coils; this causes the coil assembly to rotate, as each coil is pushed away from the like pole and pulled toward the unlike pole of the fixed field. To maintain rotation, it is necessary to continually reverse the current—so that coil polarities will continually flip, causing the coils to continue "chasing" the unlike fixed poles. Power to the coils is supplied through fixed conductive brushes that make contact with a rotating commutator; it is the rotation of the commutator that causes the reversal of the current through the coils. The commutator and brushes are the key components distinguishing the brushed DC motor from other motor types.

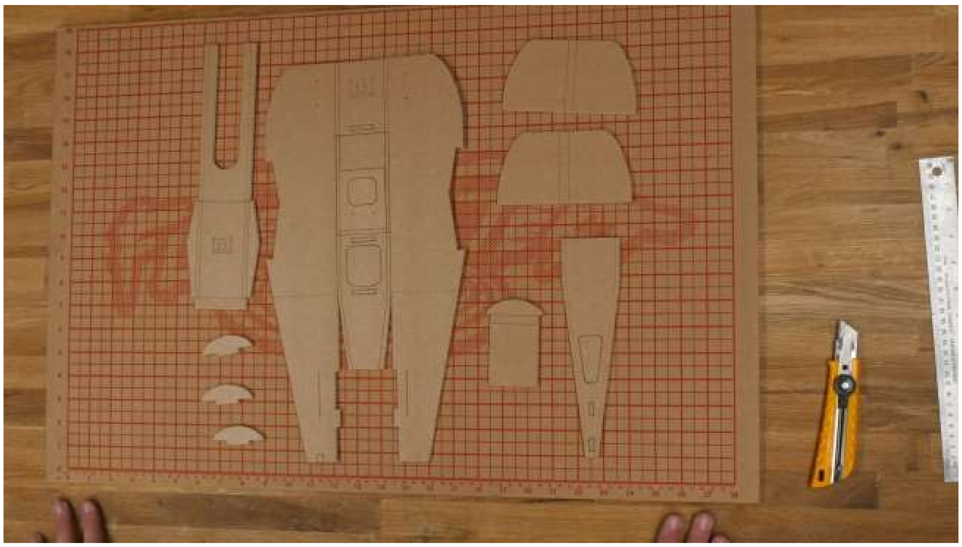


RADIO:

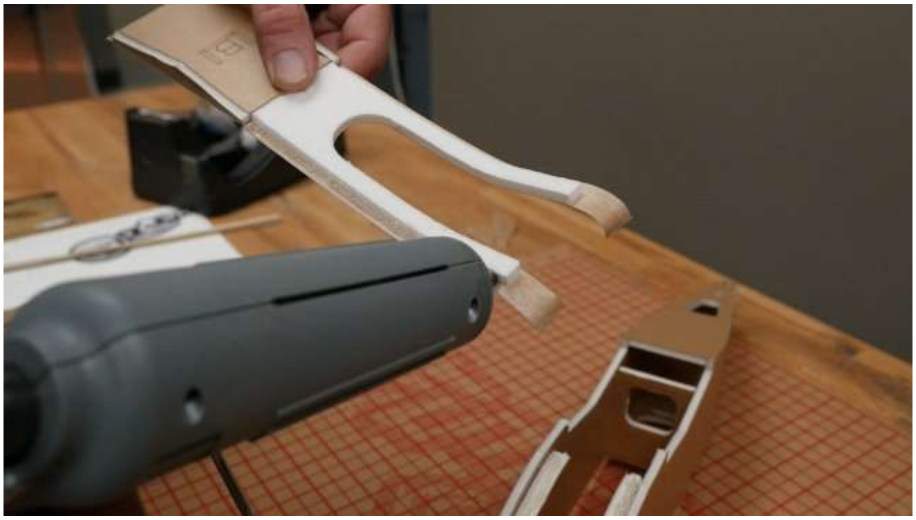
In order to control the aeroplane, we used a 2.4 Ghz radio controller to fly the airplane.Bluetooth devices intended for use in short-range personal area networks operate from 2.4 to 2.4835 GHz. To reduce interference with other protocols that use the 2.45 GHz band, the Bluetooth protocol divides the band into 80 channels (numbered from 0 to 79, each 1 MHz wide) and changes channels up to 1600 times per second. Newer Bluetooth versions also feature Adaptive Frequency Hopping which attempts to detect existing signals in the ISM band, such as Wi-Fi channels, and avoid them by negotiating a channel map between the communicating Bluetooth devices . Different versions of Wi-Fi exist, with different ranges, radio bands and speeds. Wi-Fi most commonly uses the 2.4 gigahertz (12 cm) UHF and 5.8 gigahertz (5 cm) SHF ISM radio bands; these bands are subdivided into multiple channels. Each channel can be tim-shared by multiple networks.

Procedure:

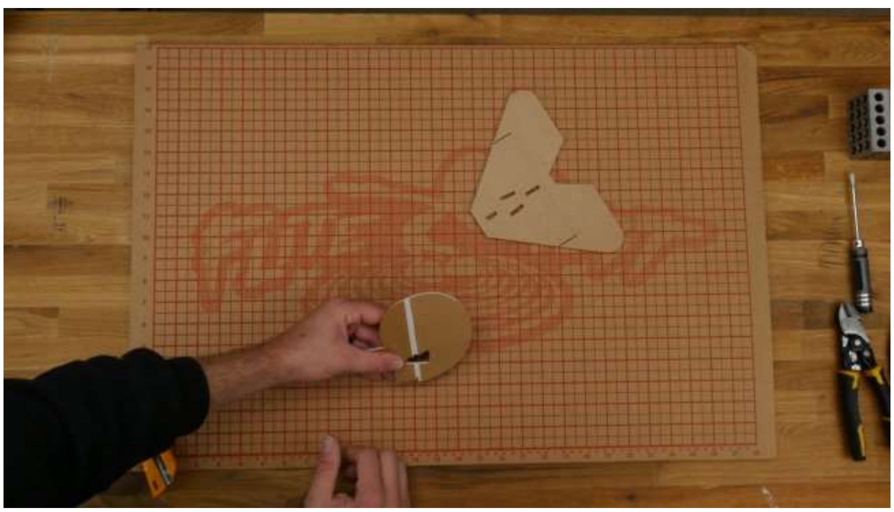
1. Print the plans in A1 sheet
2. Paste them on depron foam. Cut them out.



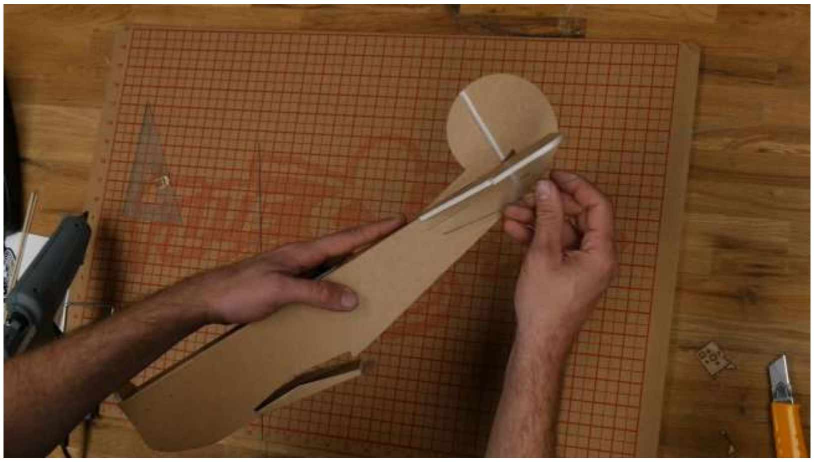
3. After the fuselage is dry, glue down the bottom plate. Make sure you hold it nice and square while it dries.
4. Add the notch piece and glue it down to the back of the fuselage. Reinforce the fuselage with the cheek doublers.
5. When the doublers are dry, install the bottom wing saddle piece to finish off the fuselage.



6. Remove the rudder and elevator tail pieces. Cut a single sided bevel on the thicker portion of the stabilizer.



7. Repeat the same process on the rudder. Attach the elevator to the fuselage. After the elevator is dry, attach the rudder.
8. Install your control horns and push rods. Then install your servos.



9. Remove all three wing foam pieces. Start with the smallest wing and score along the joint. Install the four under camber gauges, and glue the wing down when you're happy with the fit.

10. Install the dihedral gauges and hold the center section down to make the dihedral. When you're happy with the fit, glue down the seams and scrape off the excess.

11. Repeat the process with the middle sized wing. Leave the dihedral gauges on the wing.

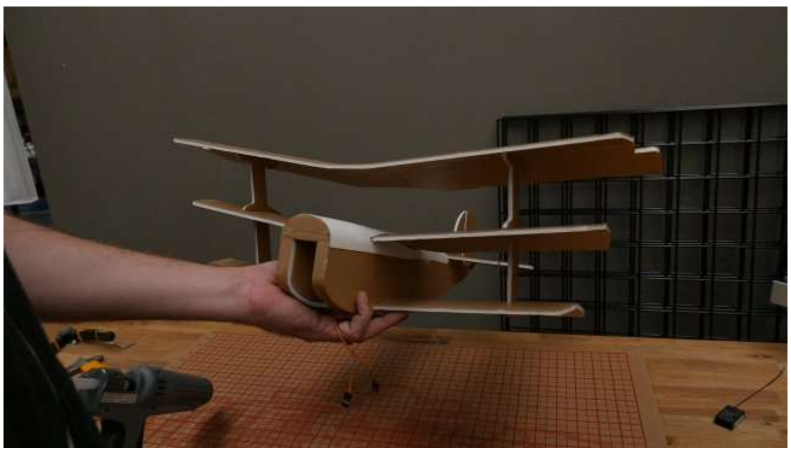
12. Score the seam on the largest wing and install the gauges. Glue the seam when you're happy with the fit.

13. Set the large wing on top of the middle wing and center it. You want the dihedral of the largest wing to match the dihedral of the middle wing. Glue the center section when you're happy with the fit.

14. Install the smallest wing on the fuselage, and glue it down.

15. Position the middle wing along the trailing edge of the center section. Make sure the two wings' leading edges are parallel to each other. Glue it down when you're satisfied with the fit.

16. Pass the wing struts through the wings, and glue them down.



17. Glue the formers on top of the fuselage. Install the poster board piece on top of the fuselage.

18. Install the cobains on the wings. After they're dry, flip the plane over and install the landing gear, wheels and tail skid.

19. Once the landing gear, wheels, and tail skid are installed, install and connect your electronics.

20. Assemble and install the cowling, then take it out for a maiden!

Observation:

1.Increase in surface area of the wings increases the upper thrust of the plane.

2.Increase in the speed of the plane also increases thrust of the plane.

3.Increase in thrust of the plane increases the weight of the plane making it harder to lift off when you move the control surfaces.

4.Propellers experienced very high amounts of drag. They also brought about unwanted sideways and rotational motion that hampered efficient flight.

5.The plane flew for only 5 minutes before recharge.

Result:

As the plane flew, principle of aerodynamics was verified.

Battery power is very limited capacity and is thus suitable for only short ranged real applications.

Propeller powered airplanes proved to be incredibly inefficient due to drag. Since the velocity of tip of the propeller is multiple times higher than the velocity of plane itself. Drag is directly proportional to square of velocity so that propellers experience high amounts of drag.

Precautions:

1.The depron foam should be properly cut.

2.Motors should be carefully handled.

3.Make sure to use hot glue.

4. Sharp tools should be handled with care.

5.There must be fully charged batteries in the radio controller

Sources of error:

1.Motors can malfunction

2.Hot glue might not be properly heated

3.Tools can be extra sharp

4.Batteries might not have any charge

5.Radio controller can malfunction

Applications of Airplanes

1)Military purpose

Airplanes also plays are huge role in the military. Fighter planes are used for aerial combats and to destroy enemy aircraft. The function of the ground attack airplanes on the other hand are to disable and destroy Earthbound targets. Bombers are used against strategic targets, such as airfields, oil refineries and factories. Other military uses of airplanes include surveillance, reconnaissance, and military personnel and equipment transport.

In times of disaster, military aircraft is also used for search-and-rescue operations. Search and rescue operation is considered as a "multi-hazard" discipline, and it is the primary response in disasters like earthquakes, hurricanes, flood, HAZMAT releases and terrorist activities. The United States Air Force takes care of inland operations, while the U.S.Coast Guard takes the lead in maritime search and rescue.

2) Telescope Observatory

Stratospheric Observatory for Infrared Astronomy (SOFIA) is a project conducted by NASA and the German Aerospace Center to maintain an airborne observatory station. SOFIA is based on a Boeing 747SP that has been modified to include a large door in the aft fuselage that can be opened in flight to allow a 8.2 ft diameter reflecting telescope access to the sky.

Able to fly anywhere in the world, the observatory is able to get above most water particles in the atmosphere for more clear infrared imagery.

3) Firefighting

The DC-10 Air Tanker has been in service as an aerial firefighting unit since 2006. The turbofan-powered aircraft carry up to 12,000 US gallons of water or fire retardant in an exterior belly-mounted tank, the contents of which can be released in eight seconds. Three air tankers are currently in operation, with the call-signs Tanker 910, Tanker 911 and Tanker 912.

4)Transportation

Nearly 100,000Planes are scheduled each day carrying nearly 8 million people. Airplane don't only transport people but also export and import cargo around the world. They are also used for carrying medical instruments around the world and also used for observing the weather.

5)Air Shows

An air show is a public event where aircraft are exhibited. They often include aerobatics demonstrations, without they are called "static air shows" with aircraft parked on the ground. Some airshows are held as a business venture or as a trade event where aircraft, avionics and other services are promoted to potential customers. Many air shows are held in support of local, national or military charities. Military air firms often organise air shows at military airfields as a public relations exercise to thank the local community, promote military careers and raise the profile of the military.

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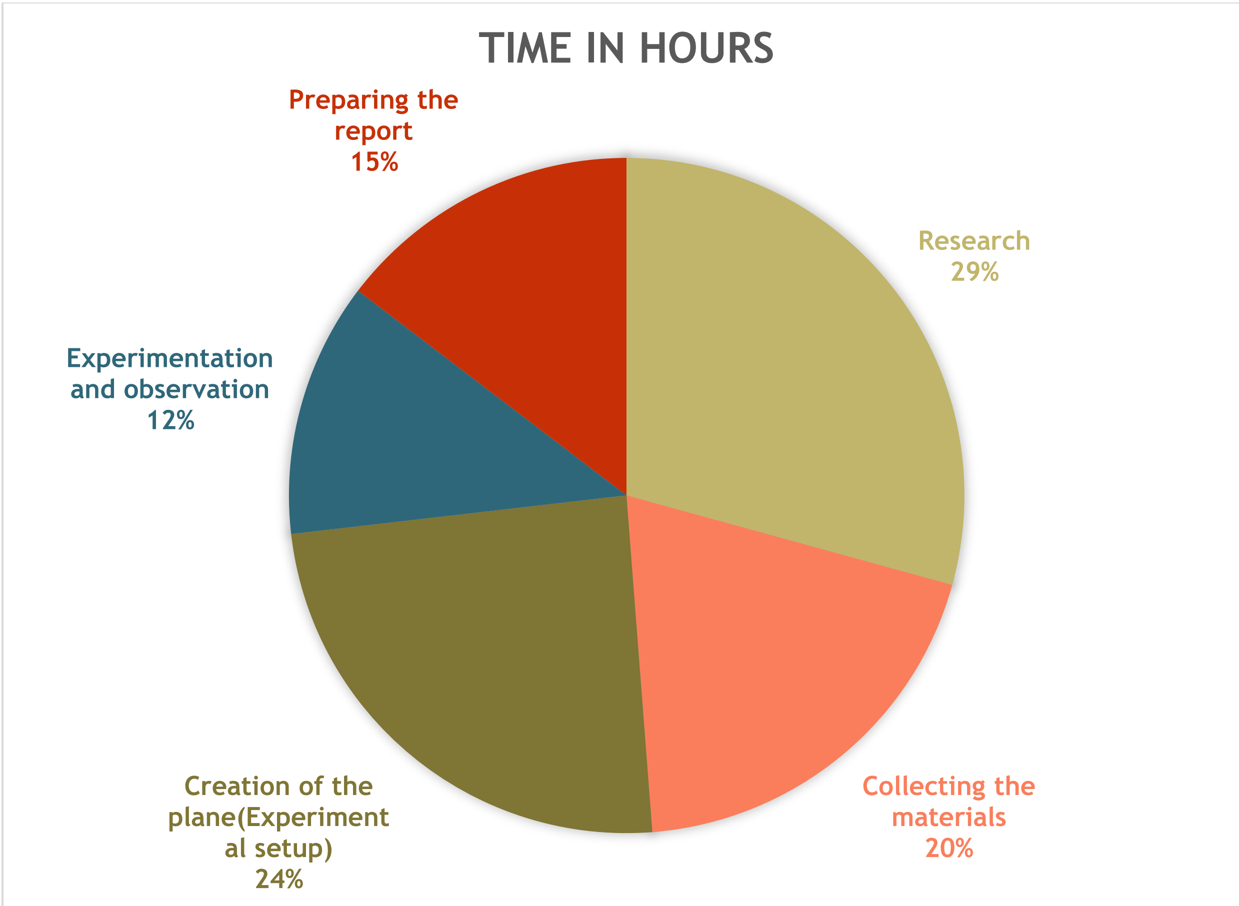
Activity	Time in hours
Research Selecting project, gathering information	6
Collecting the materials	4
Creation of the plane(Experimental setup)	5
Experimentation and observation	2.5
Preparing the report Calculating and compiling the readings, formatting the text, creating diagrams	3


TIME IN HOURS
Preparing the report 15%
Research 29%
Experimentation and observation 12%
Creation of the plane(Experimental setup) 24%
Collecting the materials 20%