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Design and Analysis of the Aircraft Engine Propeller

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Abstract*: Thrust is the force that move the aircraft through the air. Thrust is generated by the propulsion system of the aircraft. A propeller blade's thrust, depends on the angle of blade combined with its speed. The performance of aircraft fitted with fixed pitch or ground adjustable propellers is very much dependent on the chosen blade angle. Fixed pitch propellers operate at best efficiency at one combination of shaft power and airspeed. Blade angle parameter is usually chosen to produce maximum performance at a particular flight condition. So in this project I have modified propeller blade angle, temperature, pressure, density, velocity are analysed and compaired.

Keywords: Rust, Blade, Angle, Pitch, Propeller Diameter, Pressure, Temperature, Analysis.

I. INTRODUCTION

The propeller blade is an airfoil which propels the airplane through the air by converting the rotating power of the engine into thrust. Blades are twisted to optimize the performance of the propeller based on variable operating conditions. A propeller is designed to be compatible with a specific engine, in order to achieve maximum thrust or efficiency and reliability from the aircraft. Even though the propeller might fit another engine shaft, only the propeller manufacturer can determine whether it is suitable for use on a particular aircraft. Installation requirements are available for all McCauley props. Propellers are generally changed either to upgrade performance or to restore original performance compromised by wear and tear. Whatever the reason, changing propellers deserves careful consideration. The propeller is intimately linked to aircraft performance and operates in partnership with all other components. Many factors can enhance or impair performance.

A. Common Terms

1) *Blade:* One arm of a propeller from hub to tip.
2) *Hub:* Centre section of the propeller which carries the blades and is attached to the engine shaft.
3) *Spinner:* A metal cover enclosing the propeller hub, which improves the appearance of the propeller and may also streamline airflow for engine cooling purposes.
4) *Blade Tip :* The part of the blade furthest from the hub.
5) *Blade Shank:* The section of the blade nearest the hub.
6) *Blade Butt:* The portion of a blade inside the hub used to retain the blade.
7) *Blade Camber Surface:* The cambered or most-cambered side of a blade (visible from front of the aircraft).
8) *Blade Face or Thrust Surface:* The flat side of a blade (normally visible from the cockpit of the aircraft).
9) *Blade Leading Edge:* The forward full “cutting” edge of the blade that leads in the direction of rotation.
10) *Blade trailing edge* The continuous edge of the blade that trails the leading edge in the direction of rotation. The measurement between the leading edge and the trailing edge at a given station.
11) *Chord Line:* A theoretical straight line (perpendicular to blade length) drawn between the leading and trailing edges of the blade.
12) *Blade Angle:* The angle between the chord line of a propeller blade section and a plane perpendicular to the axis of propeller rotation
13) *Blade Angle Settings :* Low and high angle settings of a controllable-pitch propeller for Feather, reverse, latch and start locks which are determined by built-in mechanical hard stops.

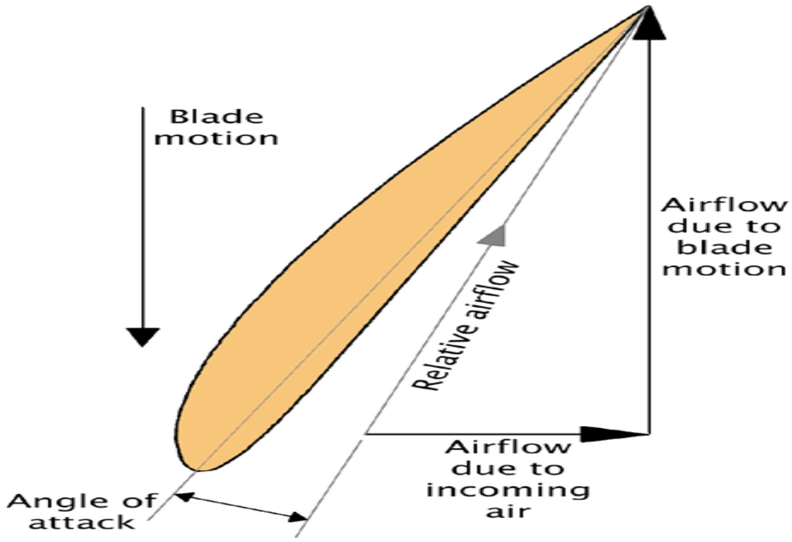

Fig. 1 Blade

B. Changing propellers

OEM Type C

1) Ertificate
2) One-Time Field Approval
3) Supplemental Type Certificate
4) *OEM Type Certificate:* Any propeller that appears on the Original Equipment Manufacturers (OEM) approved equipment list, on the Aircraft Type Certificate Data Sheet, is automatically approved for that application. No further paperwork is required.
5) *One-Time Field Approval:* More subjective in nature, the One-time Field Approval changes for every situation and is heavily dependent on the personality and experience of the FAA representative. In general, the more reasonable the request, the more likely it is to be granted. There are only two things for certain about the One-time Field Approval:
6) It requires the endorsement of the FAA • It has to have some degree of technical justification
7) *Supplemental Type Certificate (STC):* The STC is the easiest way to modify an existing airplane in the field. Most owners, operators and mechanics who wish to upgrade propeller performance will use STCs.Single-component STCs involve a specific propeller that has been approved for a specific aircraft. For example, the single-component STC is commonly used to upgrade an aircraft from a two-bladed to a three-bladed propeller. It may also be used by owners or operators who are not satisfied with the performance of their original propeller.

II. DESIGN

Propeller Blade 1

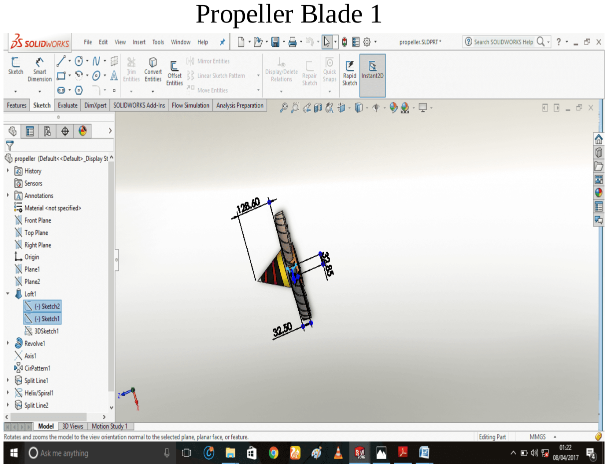

Fig. 2 Propeller Blade 1

Propeller Blade 2

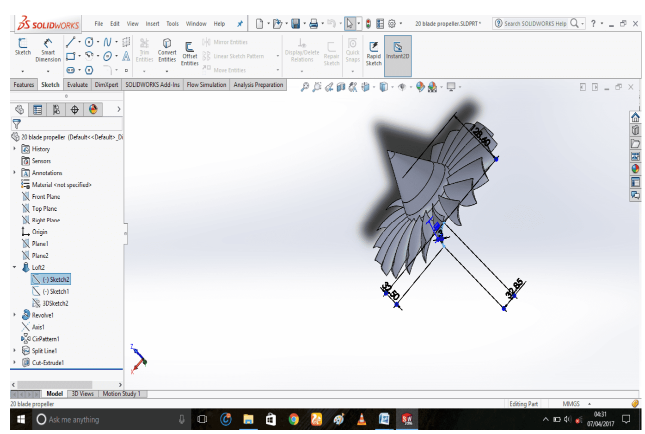

Fig. 3 Propeller Blade 2

Blade Shaft 1

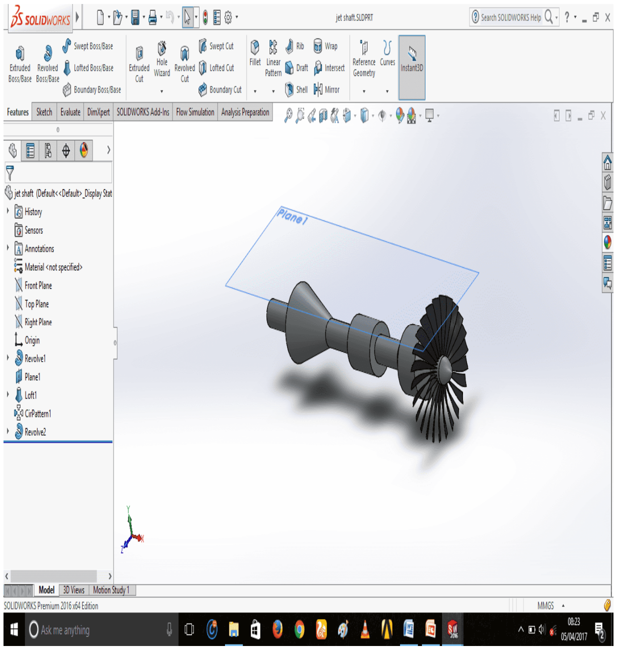

Fig. 4 Blade Shaft 1

Blade Shaft 2

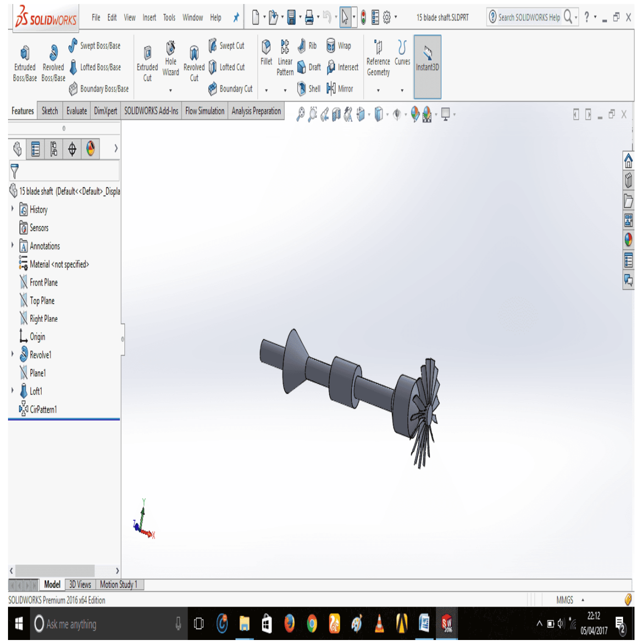

Fig. 5 Blade Shaft 2

A. Assembly

Assembly of Propeller 1

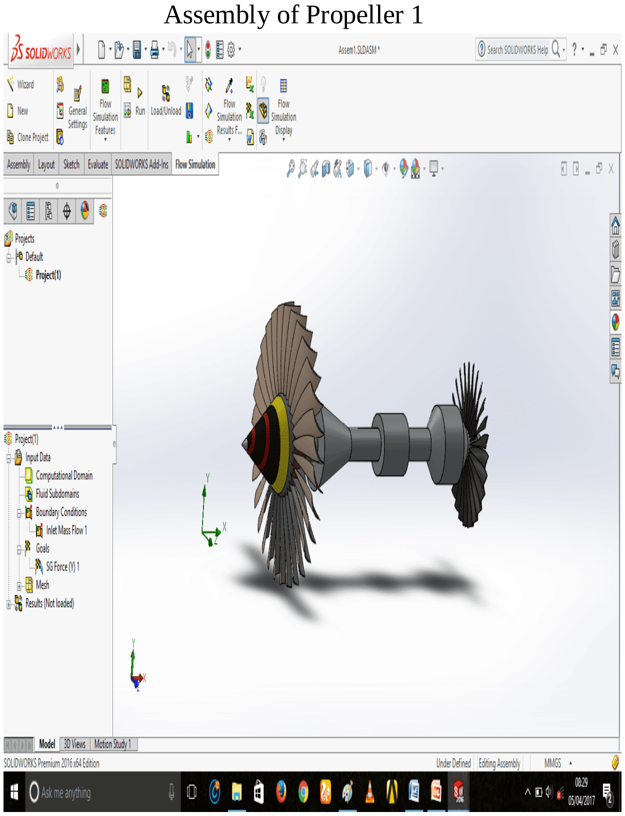

Fig. 6 Assembly of Propeller 1

Assembly of Propeller 2

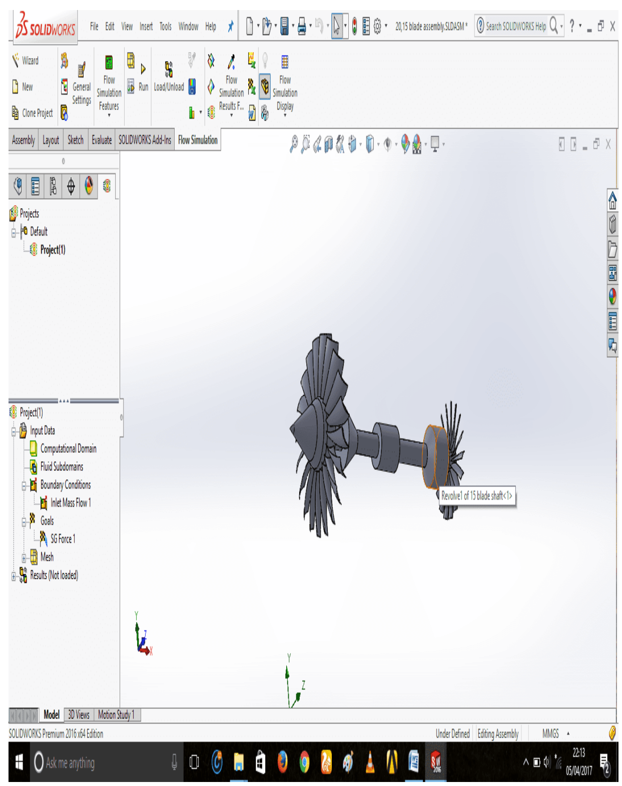

Fig. 7 Assembly of Propeller 2

Propeller 1 have 30blades of 15degree and 25blades of 15degree
Propeller 2 have 20blades of 20degree and 15blades of 20degree

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Analysis

Pressure Analysis of Propeller 1

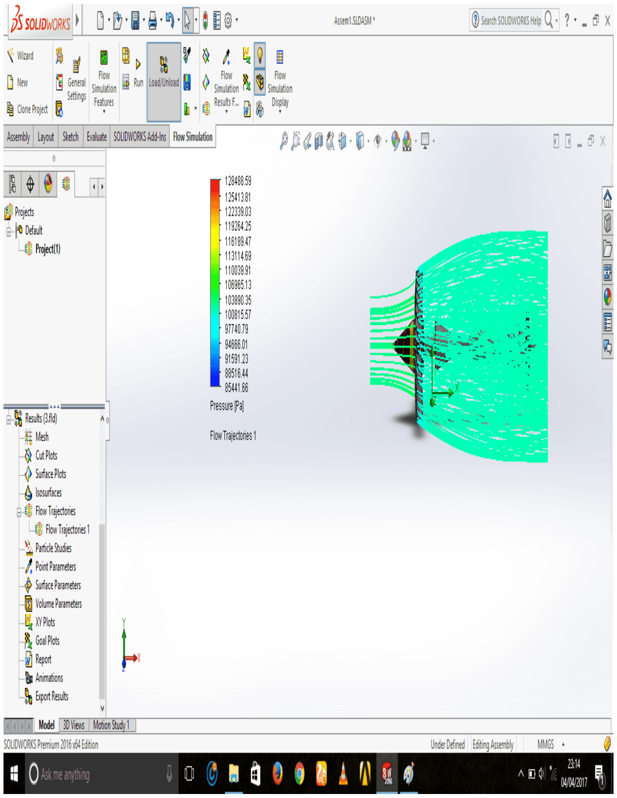


Fig. 8 Pressure Analysis Propeller 1

Pressure Analysis of Propeller 2

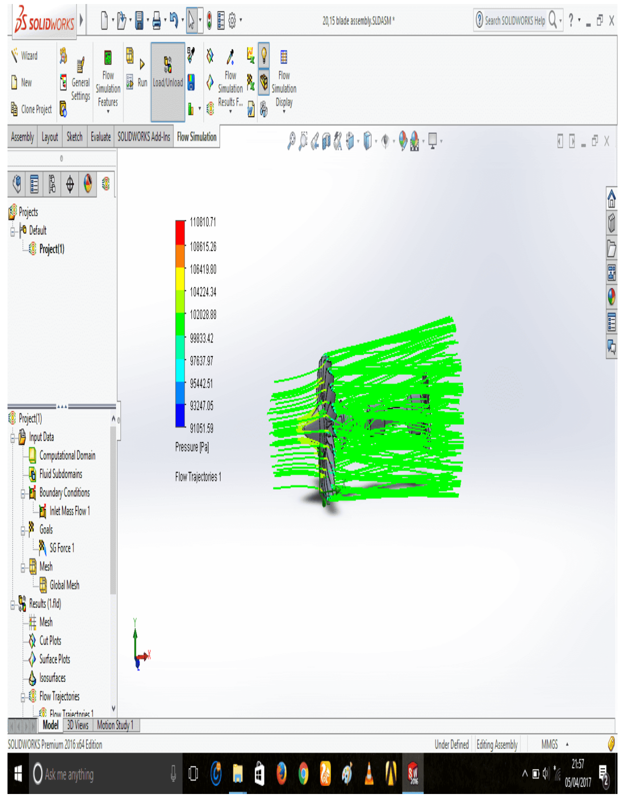


Fig.9 Pressure Analysis Propeller 2

Density Analysis of Propeller 1

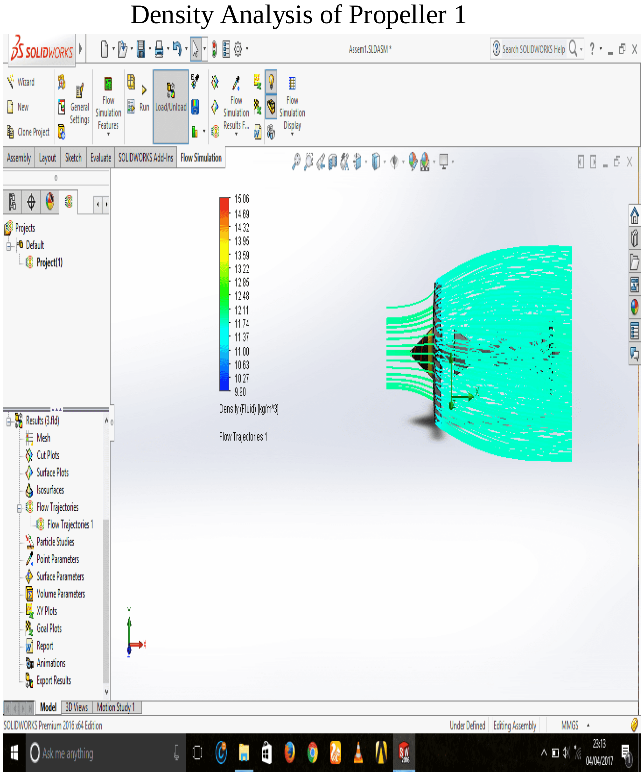


Fig. 10 Density Analysis Propeller 1

Density Analysis of Propeller 2

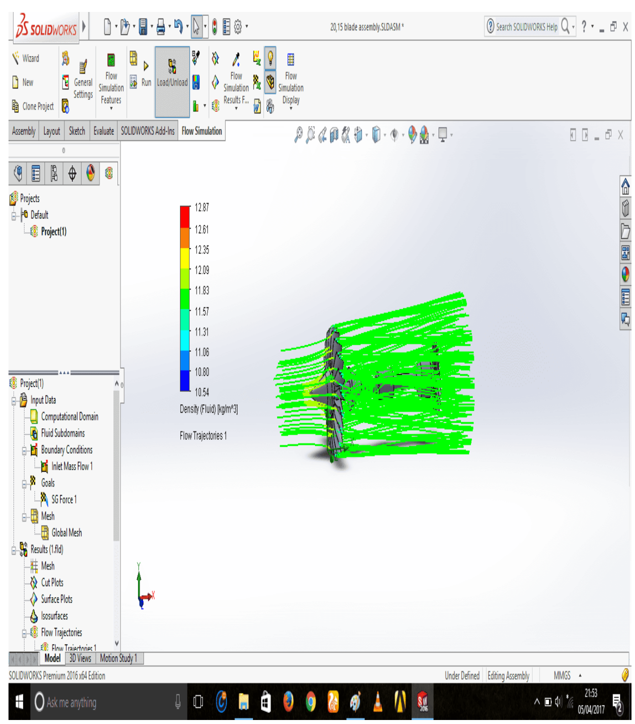


Fig. 11 Density Analysis Propeller 2

Temperature Analysis of Propeller 1

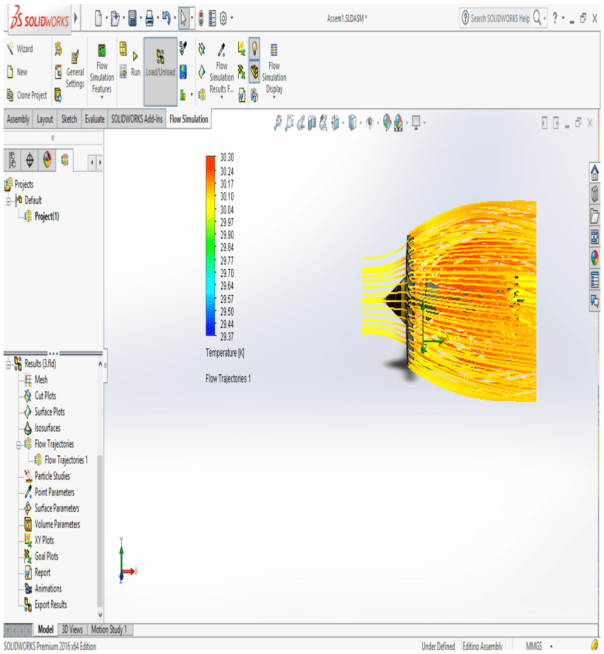


Fig. 12 Temperature Analysis of Propeller 1

Temperature Analysis of Propeller 2

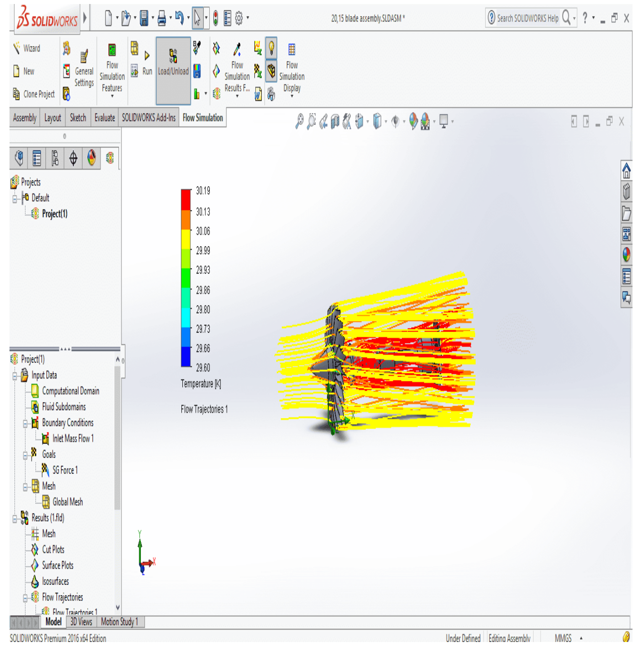


Fig. 13 Temperature Analysis of Propeller 2

Temperature(fluid) Analysis of Propeller 1

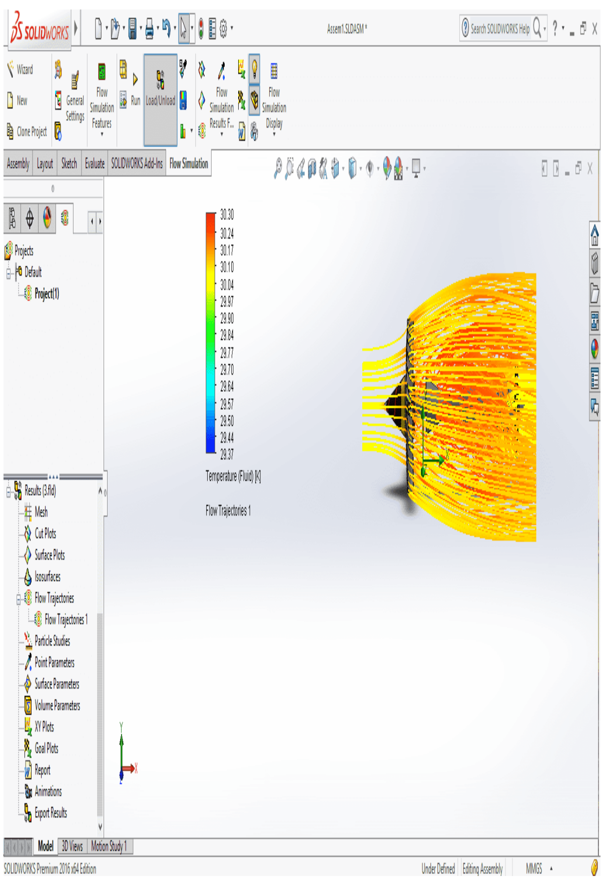


Fig. 14 Temperature(fluid) Analysis of Propeller 1

Temperature(fluid) Analysis of Propeller 1

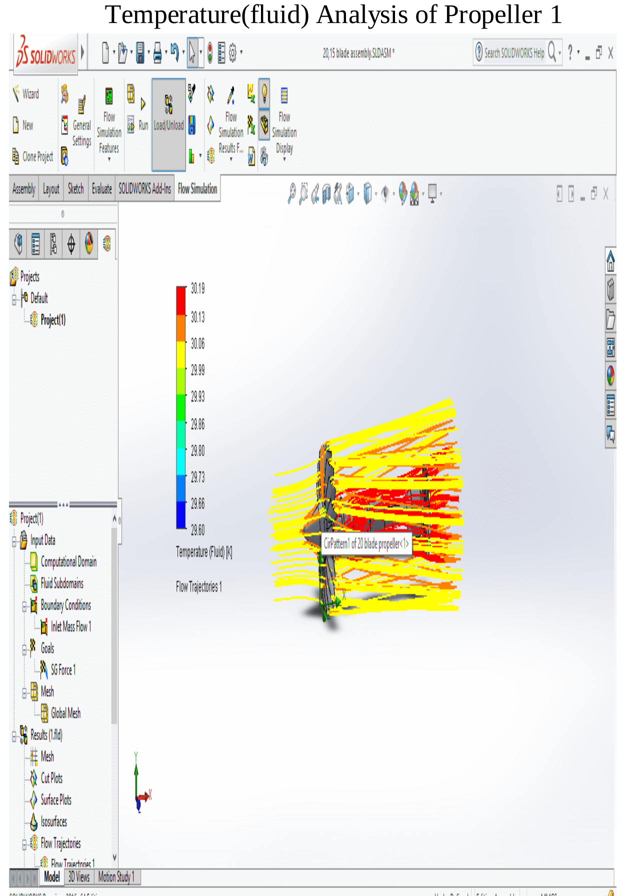
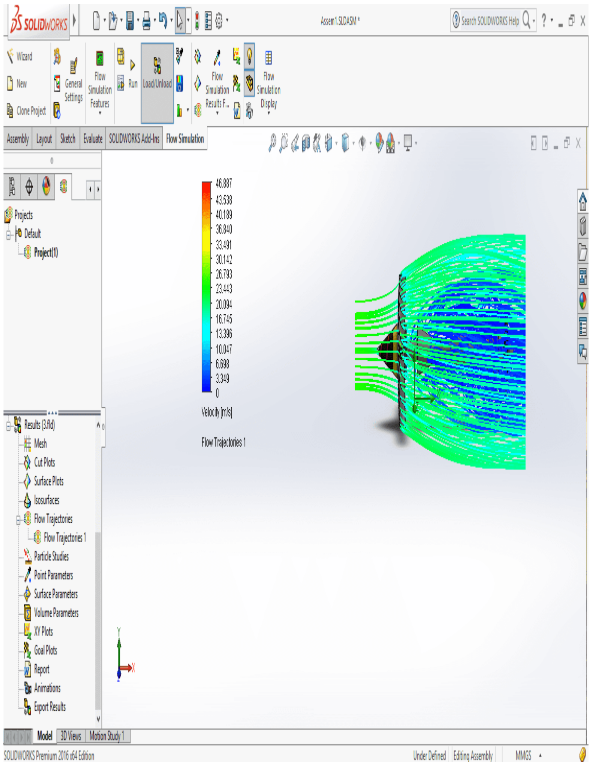


Fig. 15 Temperature(fluid) Analysis of Propeller 2

Velocity Analysis of propeller 1



Velocity Analysis of propeller 2

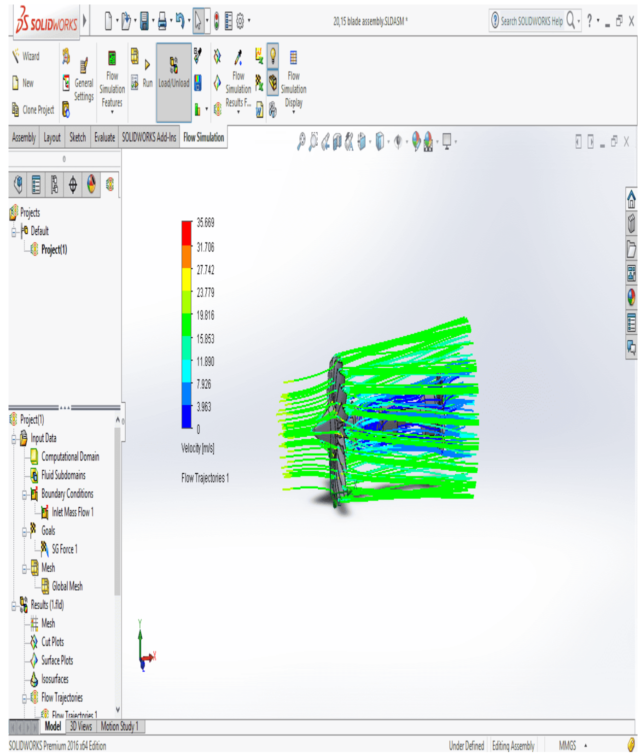


Fig. 16 Velocity Analysis of propeller 1

Fig. 17 Velocity Analysis of propeller 2

III. RESULT AND DISCUSSION

A. Comparison

Table 1

PROPERTIES	PROPELLER -1	PROPELLER -2	DIFFERENCE (Percentage)
Density (kg/m^3)	11.37	11.83	3.88
Pressure(Pa)	100815.57	104224.34	7.23
Temperature Fluid(K)	30.17	30.06	0.36(dec)
Temperature(K)	30.24	30.13	0.36(dec)
Velocity(m/s)	26.793	23.779	11.24

IV. CONCLUSIONS

To summarise, the methods used in carrying out the analysis are sufficient to obtain rough estimates of the propellers' performance, in the case of radio-controlled aircrafts like the one used in this thesis. For real aircrafts though, software with greater accuracy and computability should be used instead, and wind tunnel tests should be carried out. The design process and the variables tested with have led to the conclusion that not much can be done to increase thrust without penalty on efficiency. In most cases it was found that an increase in one would result in a decrease of the other. Only in certain cases are both able to be increased, but only to a minimal extent. As a whole, the thesis project can be said to have achieved its primary aims on objectives of producing a propeller with less heat generation, while at the same time maintaining a sufficiently high level of efficiency. However, more actions need to be taken to minimise errors where possible, though in some cases it may be impractical due to increasing difficulty and software runtime, in the progression towards more accurate results.

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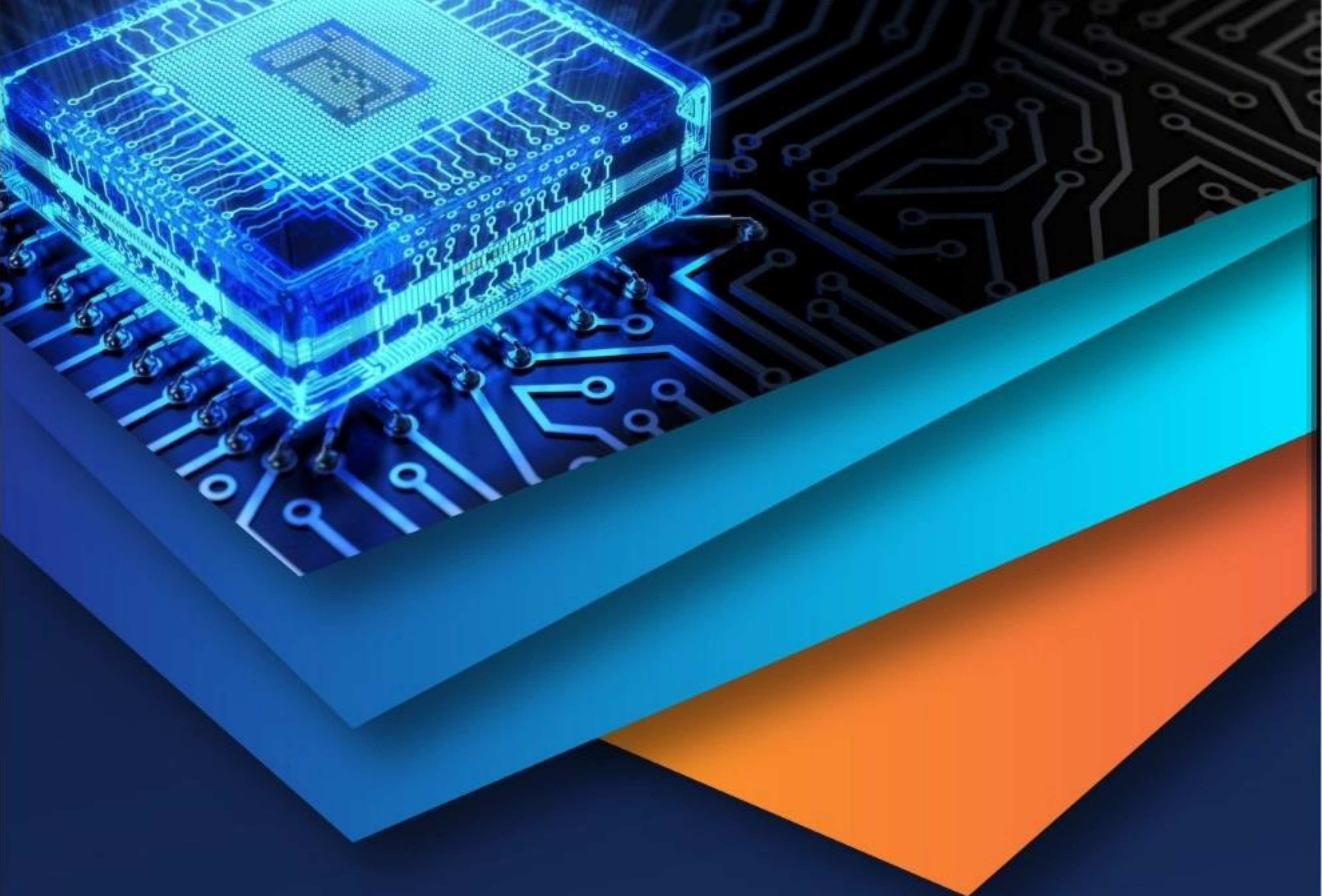

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