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A2_9 Thunderbirds Are Go!

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Abstract

Thunderbird 2 is the largest of the flying vehicles in the Thunderbirds TV show, broadcast in the 1960s. We adopted a simple mathematical model using the lift equation in order to determine whether or not it would be capable of flying. We found that at it's top speed of 2240ms^{-1} [2], the value of its lift would be 8.53×10^8 N, which is greater than its weight, 4.86×10^6N, so flight would be possible.

Introduction

International Rescue are a fictional group in the series Thunderbirds who save the day by using the eponymous Thunderbirds, futuristic vehicles which travel at incredible speeds. While there is much debate about which Thunderbird is the best amongst fans, many argue for Thunderbird 2 as it is arguably the most versatile of the Thunderbirds, and it appears in almost every episode. Thunderbird 2 is a large aircraft that carries a variety of useful equipment that are used to solve a variety of problems. However, the lack of aerodynamic shape and huge size of Thunderbird 2 have lead many to speculate that it would not be capable of flight. This paper will discuss its aerodynamic qualities of the aircraft's wings and determine whether or not flight would be possible.

Theory

To calculate if Thunderbird 2 is capable of flight we decided to use a simple model where it is assumed that its wings are the standard wing shape known as an aerofoil. From here we used

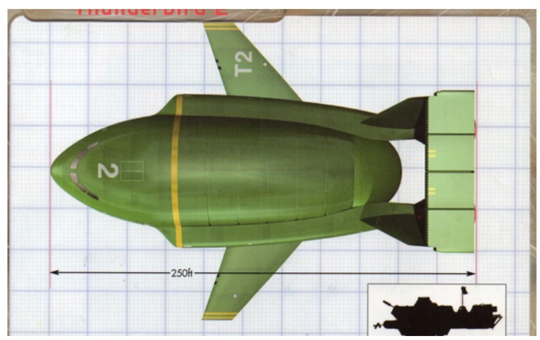

Figure 1: A diagram showing the dimensions of Thunderbird 2 each square is $23 \times 23ft$ [2].

the lift equation [1],

$$L = C_L \frac{\rho v^2}{2} A, \tag{1}$$

where L is the lift force, C_L is the lift coefficient, ρ is the air density, v is the velocity and A is the area of the wings. We first measured of the wings using by counting how much of the background squares in Fig. 1 had been covered by the wings and found that A has an approximate value of 1984ft^2 (184.3m^2). The value of the lift coefficient is determined by the shape of the wing and the angle of attack which is the angle between the wing and direction of motion [3]. For determining this we took a middling estimate of an angle of attack of 10° using Fig. 2 as the actual angle is unknown. As the wings were assumed to be aerofoils, we were able to use the graph in Fig. 2 to find the lift coefficient to be approximately 1.5.

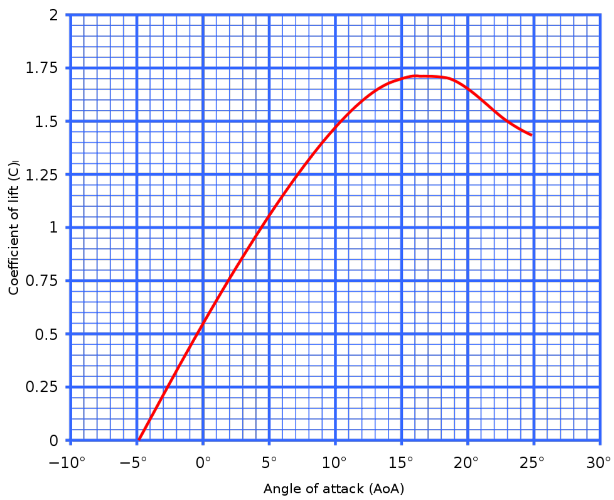

Figure 2: A graph showing the relationship between the angle of attack for an aerofoil and lift coefficient [4].

For Thunderbird 2 to achieve flight the lift force from Eq. 1 must be equal to or greater than the weight of the aircraft:

$$mg = C_L \frac{\rho v^2}{2} A. \tag{2}$$

Results

We used a value of 4.59×10^5kg [2] for the mass which includes both the mass of the vehicle itself and its payload and calculated a weight of 4.86×10^6 N. Assuming that the air pressure is standard air density 1.23kgs^{-1} [5] and that Thunderbird 2 is traveling at its top speed of 2240ms^{-1} [2]we find that the lift force is 8.53×10^8 N meaning that it would be able to fly.

Conclusion

We found that Thunderbird 2 would be capable of flight when at top speed. This does not take in to account whether or not take off for such a large vehicle would be possible and more analysis would be required in order to answer this question. Our model was a simplistic assuming that the wing were aerofoils, however, this is not actually the case for Thunderbird 2 as, when viewed in the show, the wings are essentially flat and would offer much less lift. We also did not take into account the aerodynamics of the rest of the aircraft as this would also effect whether or not it would be able to fly. For example the effect of drag on Thunderbird 2 would be extreme due to it's high velocity and large size. The heating effect of drag would be difficult to quantify because the Thunderbirds are made of a fictional metal [2] and therefore there is no known specific heat capacity. We believe more complex models are required to fully answer this question.

References

[1] `https://www.grc.nasa.gov/www/k-12/airplane/lifteq.html` [Accessed 29 November]

[2] `https://thunderbirds.fandom.com/wiki/Thunderbird_2` [Accessed 29 November 2021]

[3] `https://www.grc.nasa.gov/WWW/k-12/airplane/incline.html` [Accessed 29 November 2021]

[4] Abbott, I. and Doenhoff, A., n.d. Theory of Wing Sections. Dover Pubns.

[5] `https://www.iso.org/standard/7472.html` [Accessed 29 November 2021]