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A2_3 The Great Eggscape

S. Neumann, A. Crossland, A. Fleetham, J. Goldie and G. Holyoak

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

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Abstract

The movie *Chicken Run* sees a flock of chickens attempt to escape certain death by building an aircraft out of coops. By estimating the dimensions of this craft, *The Old Crate*, we calculated that a takeoff speed of 56 ms^{-1} would be required for flight, which gave a kinetic energy of 309 kJ. Reviewing the movie showed that a total of 40 chickens power the craft through pedalling. Assuming 100% efficiency we calculated that the chickens could only supply 14.4 kJ of energy, hence, would not in fact escape their fate.

Introduction

The award-winning movie, *Chicken Run*, tells the story of a flock of chickens destined for the chop, and their desire to escape to live a peaceful life in the countryside. It follows the main character, Ginger, in her many failed attempts at escaping the farm until she is inspired by the stories of the old rooster, Fowler, and his days in the British RAF. They devise a plan to build a plane, *The Old Crate*, out of chicken coops and use it to fly to freedom.

In this paper we determine whether the chickens could provide enough energy, through pedalling, for *The Old Crate* to reach takeoff speed.

Theory and Calculations

Throughout our calculations we made a few assumptions;

- the flight of *The Old Crate* is analogous to that of a bird since it involved the flapping of wings,
- there is no energy loss through friction between moving parts or drag,
- chickens can pedal.

Firstly, we determined the energy supplied by one chicken through pedalling. The movie revealed that the chickens were *Rhode Island Reds*, with a mass of 3 kg [1]. In [2] it was found that a chicken can jump around 20 cm off the ground to reach low hanging fruits on shrubbery. Therefore, using Equation 1 we calculated the energy supplied by a chicken's legs.

$$E = mgh \tag{1}$$

Where m is the mass of one chicken, g is acceleration due to gravity and h is the height jumped, which we took as 0.2 m. This gave an energy of ≈ 6 J per pedal. It was noted from the film that 40 chickens pedalled the plane, it took 60 s to reach the take off ramp and the chickens were making one rotation a second, giving an overall energy supply of ≈ 14.4 kJ.

Heavy birds require a running takeoff, as was the case with *The Old Crate*. Therefore, we calculated the takeoff speed required for *The Old Crate*. The amount of lift L required for a bird to fly must support its weight W, and is dependent on the mass flow around the wings and how much downward motion is imparted to this air flow. For vigorous flapping, a bird typically gains neither lift nor thrust during the upstroke, but does during the downstroke [3]. Therefore, we used the mean lift to calculate the speed [3];

$$L = W = \frac{1}{4} K_L \beta S_W \rho V^2 \tag{2}$$

where K_L is the aspect ratio ≈ 5 [3], β is the angle of attack taken as 0.1 rad [4], S_W is the total wing surface area, ρ is the density of air taken as 1 kg m^{-3}, and V is the speed.
The surface area S_W of each wing was calculated by estimating the width and length of each wing against a coop used by the chickens. Using Figure 1 and the dimensions of a coop from an online retailer [5], it was estimated each wing had surface area of 2.5 m^2.
Finally we calculated the weight W of *The Old Crate* at takeoff. From Figure 1 it was deduced that two chicken coops had been used to build the craft, inside the craft were 40 chickens pedalling and one rooster piloting. One chicken coop had a mass of 37 kg [5] and 41 chickens had a combined mass of 123 kg, giving on overall mass of 197 kg and a weight of 1933 N.
By rearranging Equation 2 we calculated the takeoff speed as ≈ 56 ms^{-1}.
Using the calculated takeoff speed, we calculated the Kinetic Energy required to reach this speed and therefore the energy required by the chickens.

$$KE = \frac{1}{2} m V^2 \tag{3}$$

Where m is the overall mass of the craft and V is the takeoff speed, giving a Kinetic Energy of 309 kJ.

Conclusion

We calculated that the 40 chickens pedalling were able to supply *The Old Crate* with 14.4 kJ, assuming zero energy loss through friction or drag and 100% energy transfer to the craft's wings. We determined that *The Old Crate* required a takeoff speed of 56 ms^{-1} and total energy of 309 kJ. It is clear from these calculations that the chickens would not have escaped using *The Old Crate*, and would in fact have become Mrs Tweedy's Chicken Pies.

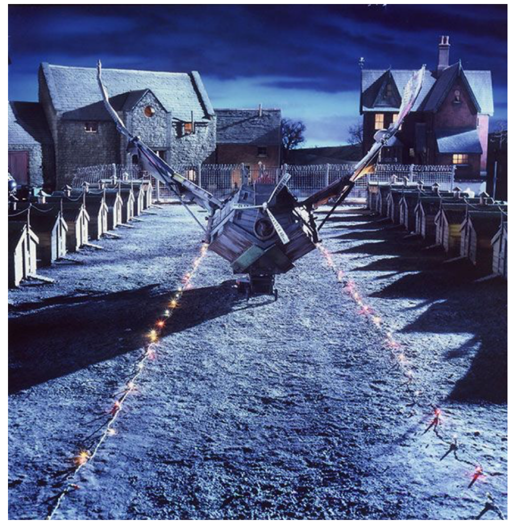

Figure 1: A still frame of *The Old Crate* on the runway. It was from this image that the size of the wings were estimated. [6]

References

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