SAE AERO REGULAR GROUND TESTING

DECEMBER 1, 2021

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Background

The main goal of this document is to display the results the team has from our testing. Our team designed and built an aircraft as our capstone project. During the design process the team took into consideration many different design parameters as well as customer requirements, and other competitions constraints. Later explained in this document the team compares the results of our real-life testing to our parameters to quantify how well our design did at meeting these parameters.

1. Cargo Design

For the design of the aircraft, it must be able to hold a size 5 soccer ball at a minimum in an enclosed space. During the testing of the aircraft, a size 5 soccer ball that was fully inflated was inserted into the nose cone of the aircraft, and the nose cone closed fully while containing the payload. The fuselage was hollow behind the nose cone, so the craft could contain additional payload in the form of weight if desired. This was not done during the testing of the aircraft. Below are two images depicting how the soccer ball was enclosed in to the aircraft.

FIGURE 2: SOCCER BALL PLACED IN CARGO BAY

FIGURE 2: SOCCER BALL ENCLOSED IN CARGO BAY

2. Total Weight

The maximum weight of the aircraft was 55 lbs. per SAE Aero Regular competition rules. The team aimed to have a loaded aircraft that weighed approximately 13 lbs. or less by the time that the aircraft was ready perform testing. The team utilized a household bathroom scale to determine use a differential weight to determine the weight of the aircraft. At the time of testing, the aircraft was determined to weigh approximately 15 lbs. fully loaded. This weight contained the Arduino system that the team was using to determine the velocity of the aircraft. This weight was within the SAE rules as well as just slightly over the teams goal of 13 lbs.

FIGURE 4: PRELOAD WEIGHT WITH TEAM MEMBER ON SCALE

FIGURE 3: WEIGHT OF THE TEAM MEMBER PLUS AIRCRAFT

3. Thrust Greater Than Drag

For the aircraft to achieve sufficient forward motion and flight, the thrust of the motor must be greater than the drag of the aircraft. During the testing of the aircraft, it achieved continual acceleration until it was beginning to take off. While the team did not measure the thrust directly, this told the team that the aircraft was producing enough thrust to counteract the drag, but the aircraft was not stable enough to achieve flight. The thrust was determined to be enough to overcome the drag forces, even though there was not enough stability for the aircraft to achieve flight in the experimental testing.

4. Wingspan

The wingspan was required to be 120 inches or less. During the testing phase the team used a tape measure and measured the wing to ensure that the design met the requirements, even though in the CAD modeling the wing was well within parameters. The wings ended up slightly larger than the designed 60 inches due to the way the wings were mounted with fiberglass. The wings measured in at 61.375 inches which is well within the allowable parameters of the competition.

5. Lift and Weight

The lift must be greater than the weight of the aircraft to fly. For testing the required lift would be approximately 15 lbs. of lift. During testing the aircraft never managed to achieve flight. The aircraft would generate enough speed and once one wheel began to lift off the ground, the craft would roll over and fail to achieve takeoff. The team believes this failure to be due to instability in the design and components not being parallel, manufacturing issues. This resulted in an unequal lift being generated by the craft, causing it to begin to roll and then that roll leading to a rollover of the aircraft. Based on the airfoil data the team calculated the required velocity for a 15 lb. aircraft, needed to achieve a takeoff velocity of approximately 37.5 ft/s.

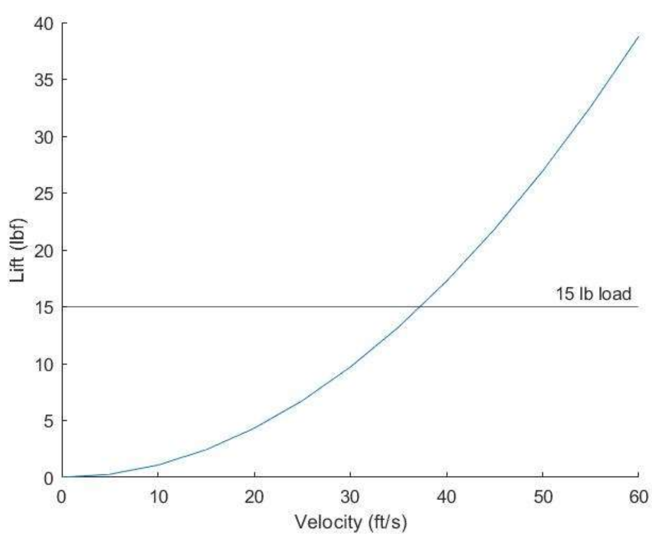

Figure 5: Velocity required to achieve lift

From the pitot tube testing data, the 37.5 ft/s velocity was not achieved before the aircraft would ultimately crash on the ground. Below are six different attempts to achieve flight. The aircraft best run had a max speed of just shy of 25 ft/s. This was 12 ft/s slower than the team was aiming to achieve during takeoff. As mentioned previously the aircraft would begin to lift off the ground but had too much drag on one of the wings and would cause a turning motion which led to the aircraft rolling. While flight was never achieved this information leads the team to believing that the aircraft was generating more lift then previously calculated in models. Another factor that affected this was the angle of attach of the wing was greater during testing then during the models. While revising the theoretical model would be beneficial the fact the aircraft never generated enough lift to fly means the aircraft would need to be rebuilt prior to changing the theoretical models to confirm this hypothesis. This ultimately is not possible due to time constraints which is why we will leave this difference in values alone.

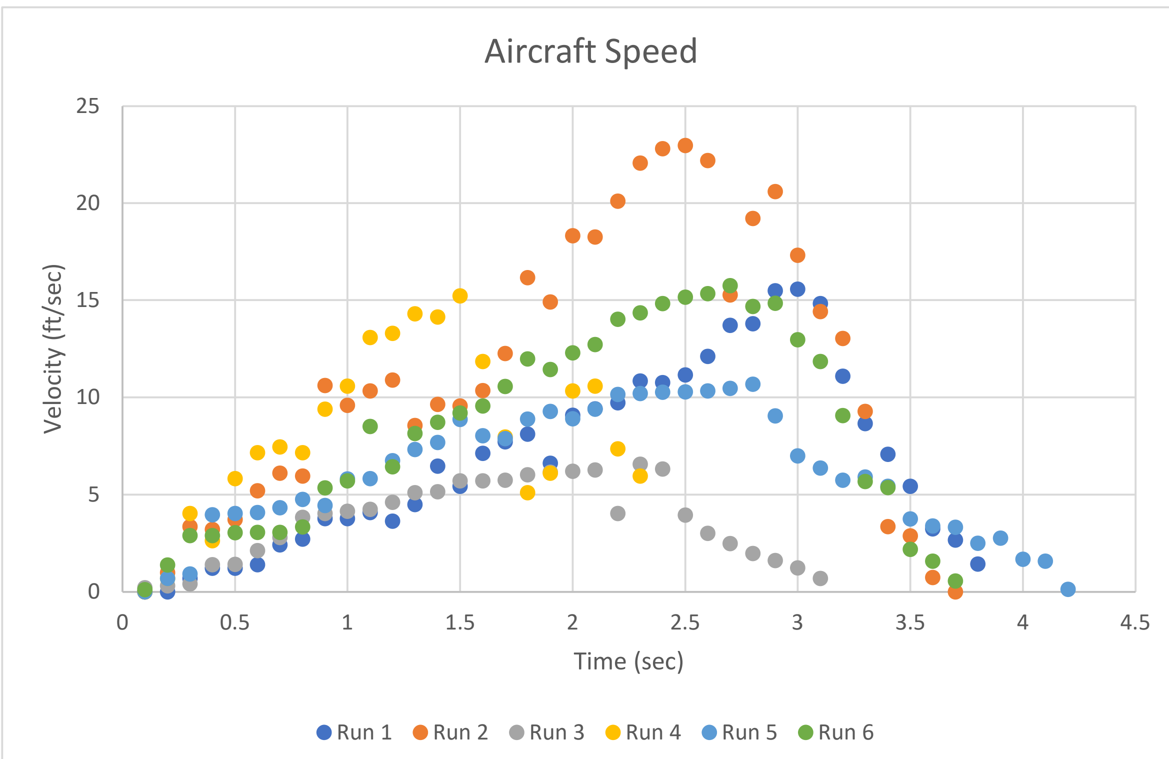

FIGURE 6: AIRCRAFT VELOCITIES DURING TESTING

6. Misc. Requirements

There are other non-measurable requirements that were met during the testing but have no associated values. The propeller was direct drive to the prop and the prop was a non-3D printed propellor and met the material requirements. The aircraft had a safety switch wired into the circuitry so could be armed and disarmed from the exterior of the aircraft. This was also a requirement of the design and was tested and functional.

7. Conclusion/Recommendations

Data collection for velocity was a success. Looking at the four fundamental forces on the aircraft the results during testing show the aircraft had more thrust than drag and had more lift than weight. Form a fundamental perspective the aircraft worked however form the realistic testing the aircraft has some major manufacturing issue that resulted in a poorer quality of the aircraft then expected. Due to this the team recommends form the data during testing multiple changes for second version of this aircraft. Things like not using fiberglass, constructing more aerodynamically smooth control surfaces, better hinge points for said control surfaces and ultimately more time.