SAE Aero Regular Spring 2021

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Abstract

Our team's goal is to reassess and redesign the previous year's SAE Aero Regular Class team and their design to understand what worked well and what could be improved. Their aircraft had to fit the rules and regulations set by the SAE Aero Regular Class competition, so ours must as well.

Our team will be completely redesigning the old team's design from the ground up. Our design changes are reflected in the CAD Model can be seen below.

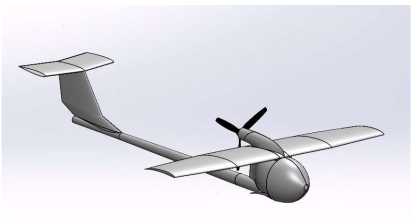

Figure 1: CAD Model

Competition Criteria

The following design rules are required by SAE Aero:

- ✓ Maximum Wingspan of 10 ft. (120 in)
- ✓ Maximum Weight of 55lbs
- ✓ Must carry a size 5 soccer ball payload (Diameter of about 8.7in.)
- ✓ 1000-Watt power limiter built into the electronics
- ✓ 1:1 gear ratio between the propeller and its drive motor
- ✓ Takeoff distance of 100ft
- ✓ Landing distance of 400ft

The following entail the goals for the team's design:

- ✓ Weight of 30lbs with extra payload weight
- ✓ Payload capacity of 1 cargo with 20lbs of payload weight
- ✓ Lift force of 35lbs
- ✓ Takeoff distance of 80ft.
- ✓ Landing Distance of 300ft.

Data and Analysis

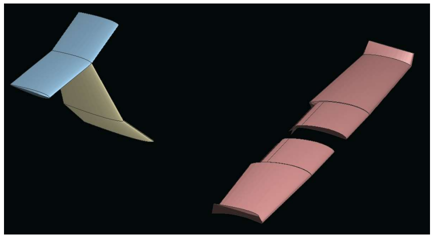

Figure 2: xFLR5 Model

Figure 3: Final design

Design Features:

- 60-Inch Wingspan
- Althaus' 7-47-6 airfoil [3]
- Fiberglass structure
- Monocoque construction
- Capacity for one soccer ball
- Taildragger Configuration
- Three blade propeller
- Pusher configuration

Scoring Calculations

Flight score is the way the aircraft gets scored during competition. While our aircraft will not be going to competition due to our timelines this metric is one of the few ways to allow our team to compare results between our aircraft and other teams not only past but future teams as well.

$$FS = 120 * \left(\frac{3 * S + W_{Payload}}{b + L_{Cargo}}\right)$$

$S = Number\ of\ Soccer\ Balls$
$W_{Payload} = Extra\ cargo\ capacity$
$b = Aircraft\ Wingspan\ (inches)$
$L_{Cargo} = Length\ of\ Cargo\ Bay\ (inches)$

The Final Design

The final design is unlike any other SAE Aero Regular design to come from Northern Arizona University. The plane will pull the air over the main wing instead of pushing the air like most planes, giving the main wing less turbulent air which in theory will help to promote better lift and control in the air. It will also be the first SAE plane at NAU to be made almost entirely of fiberglass, making it light, but strong and durable. This design will keep the aircraft stable in the air and produce the necessary lift at 45fps, or about 31mph.

Results

Measured weight of the aircraft was approximately 15 lbs. The aircraft was able to carry the payload of one size five soccer ball with no additional weight and a wingspan of less than 120 inches.

The aircraft was not able to take off during the testing of the aircraft at speeds of 25 feet per second. This was due to manufacturing flaws in the airframe.

After final assembly, the aircraft fuselage was not in line with the motor, it deviated to the right when viewed from the front of the aircraft. The wing and tail section were also angled and not perpendicular to the ground. The aircraft had issues with steering to one direction or the other during takeoff as a result.

The team corrected the steering issue by modifying the landing gear, however once the aircraft began to develop enough lift to start to become airborne, the aircraft would lose control and become extremely erratic in direction. The aircraft would begin to roll and failed to go airborne in testing. Takeoff and landing distances could not be assessed as a result and the aircraft did not meet the competition criteria. Due to this the aircraft would not complete the competition loop and therefore the project is deemed a failure.

Control surfaces had minimal effect on control of the aircraft. This indicated that they were undersized for the aircraft.

References

[1] SAE International , "2021Collegiate Design SeriesSAE AeroDesign Rules," 2021.
[2] "SAE Aero Design - Rules," SAE Aero Design, [Online]. Available: https://www.saeaerodesign.com/cdsweb/gen/DocumentResources.aspx.
[3] "AH7476", Airfoildtools.com, 2021

Acknowledgements

- David Willy