SAE Argonautics

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INTRODUCTION

The Society of Automotive Engineers (SAE) Micro Class competition is normally held as a practical testing of engineering skills offered to engineering programs.This allows teams working within the competition to learn more about practical applications of engineering in the industry. The overall goal is to create a remote-controlled aircraft using new and preexisting skills within the team, often requiring research outside of course content to broaden the members' learning perspectives.

Much of the team is new to aircraft design and practical engineering in general and this project is allowing our team to collaborate on a specific set of competition goals. The 2020-2021 team has decided not to attend the in-person competition due to possible uncertainties of future cancellation similar to the previous year's competition. This is the fourth year the UWF SAE team will be attempting the goal of making a competition ready RC plane but the first using Micro Class competition rules.

AIM

The SAE Aero team of the 20-21 academic year is to research, design, and build a small-scale aircraft following the SAE Micro competition rules. The goals and requirements specified by the competition are to design a plane of restrictive size and power output while transporting boxes and weights. The amount of cargo was decided by the team and maximized through analysis of a scoring rubric provided in the rules.

Scoring Equation:

$$Final\ Flight\ Score = FSS = FS_1 + FS_2 + FS_3$$

Where:

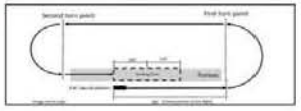
$$Flight\ Score = FS = 80 * \frac{\sqrt{W_{Payload} * Bonus}}{T_{Flight}}$$

$$Bonus = 0.5 + (1.0 * N_{large}) + (0.4 * N_{Small})$$

N_{large} = Number of Large Boxes Flown
N_{Small} = Number of Small Boxes Flown
$W_{Payload}$ = Payload Plate Weight (lbs)
T_{Flight} = Flight Time from Take − off to First Turn (s)

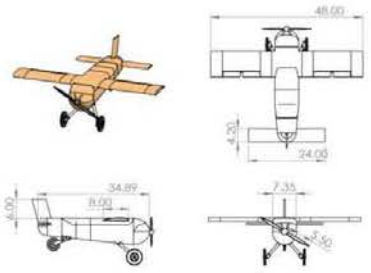
Scoring Criteria (above)

Flight Path (right)



METHOD

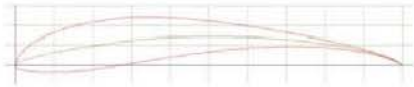
The 2020-2021 SAE Aero team's micro class competition plane must be capable of lifting cargo in the form of cardboard boxes and small metal plates. These objects may simulate passengers and cargo that a full-scale plane must carry daily and acts as the inspiration for the competition.



Dimensions of the aircraft model

The method taken to calculating the shape and size of the fuselage frame is in part from an excel workbook the previous design team set up to streamline the process of doing these calculations. Other parameters to process include lift, drag, thrust, and time to take-off.

The primary consideration to base the design from was the size limitation of a maximum four foot wingspan. It was decided that this maximum wingspan would be utilized to gain the most lift with a chord length of one foot.

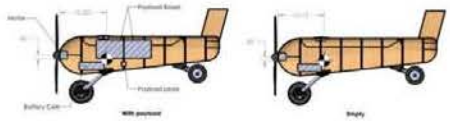


Selected Selig S1210 airfoil of the aircraft

The airfoil we selected is a Selig S1210 and is noted for having a high lift with a low Reynolds number. The importance of lift is in increasing payloads and reducing the distance required to perform a takeoff. This lift provided with the airfoil under the selected wingspan and chord is capable of transporting the required weight of cargo. This arrangement is also capable of a takeoff distance of under four feet which is another requirement under competition guidelines and mimics size constraints of platforms such as an aircraft carrier.

The frame is being constructed primarily of balsa wood which is a standard in RC design due to its light weight and relatively high strength. Some connectors have been 3D printed for a lightweight solution to complicated attachment points on the interior of the structure. The main method of attachment for parts is an adhesive epoxy for the balsa pieces that is easy to apply and provides sufficient holding strength to keep the craft together during flight and landing.

An exterior shell is made using ultracote is used to create a smooth surface for air to pass around with limited drag from otherwise exposed surfaces prior to application as it weighs less than sheets of thin balsa wood surrounding the craft.



Engineering model of the aircraft with and without loads

Within the micro-class competition there are two payloads that must be carried around a track which are payload plates and cardboard boxes. Based on the competition requirements we chose to have the craft hold two of the smaller sized boxes (2.5 oz each) and 6.9 ounces of payload plates. The analysis done to determine this used the overall scoring system and changing the number of boxes, weight, and probable time of flight. Larger boxes would provide a greater score but take too much of the limited space up and negatively impact the already limited flight surfaces shape and size.

The boxes will be held in line within the fuselage frame and be able to be taken out of the box easily using a top hatch that is fastened during flight. Weighted plates will similarly be removable once the boxes are taken from the frame. Removing the boxes and payload plates will not have a significant effect on changing the center of mass which has been found using a Solidworks model of all components inserted in the craft.

RESULTS

The SAE Aero team has finished the research and design process required to create a craft capable of meeting competition standards. Although attendance to the competition is not feasible due to previous uncertainties of Covid-19, a mock flight will be conducted with a pilot who has significant experience in piloting RC aircraft.

The final steps in the project are the finalization of manufacture and the testing of a final product. The team has scheduled the testing to be completed prior to the end of the semester in a manner similar to the competition guidelines, including a loaded and unloaded flight. Meeting with the experienced pilot will provide further insight for team members attending the test. Any flaws in the construction and design will also be visible and may be acted upon by future teams using the team's development process.

CONCLUSIONS

To conclude, the team is nearly complete with the micro class RC plane designed with the SAE Aero 2020-2021 competition ruleset. Thanks to the previous team creating reference material, the current team has taken less time to refine the new design for different goals. The team hopes that this further use of material in creating a new design will be helpful for future teams able to attend competitions once they move back towards an in-person setting. Our other hope is for future engineering students to see the value of this project and have a positive outlook on the team-centered process.

Team leader preparing a piece of the fuselage frame.