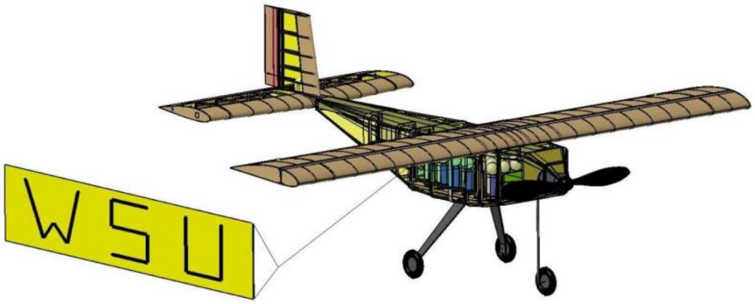
# El Agave




**Missions**

The AIAA Design Build Fly competition consists of 3 flying missions and a ground mission. These missions were designed to test the aircraft's speed, endurance, towing capabilities, and accessibility to the payload bay/bays.

Mission 1 was a demonstration mission that was designed to allow the team to prove that our vehicle could do what it was designed to do. It consisted of a 20 foot take off distance along with 3 laps around the course with no attached payload. There was a 5 minute maximum time limit on this mission.

The second mission was the passenger payload mission. The scoring equation for this mission gave a good score to a team that was both fast and carried a lot of passengers. The mission was to carry passengers for 3 laps around the course in a 5 minute time window.

The third mission was a banner towing mission. The scoring equation for this mission promoted a long banner and as many laps as possible within the 10 minute time limit. The 20 foot take off distance was in effect for this mission as well. Another stipulation was that the banner's aspect ratio had to be between 5 and 10, it could not frey in flight, and it must remain in a similar orientation as the one in the picture above.

The ground mission was a mission designed to test the speed at which a member of the team was able to make the aircraft flight ready. It was a timed mission where a team member must install the mission 2 and 3 payloads, demonstrate the payload is secure, and remove the payloads.

**Requirements and Constraints**

Apart from the mission related requirements and constraints, some others that are worth mentioning are: unassisted take off for all flying missions, a single type of battery is permitted, safe landing is mandatory for a successful mission, and the maximum wingspan is 5 ft just to name a few.

With the all the competition's imposed requirements and constraints, the team estimated some characteristics that El Agave ought to have for being competitive: mission 2 average cruise speed of 90 ± 5 ft/s, mission 3 average cruise speed of 65 ± 5 ft/s , stable turn radius of ~51 ft, stall speed of 41.4 ft/sec for mission 2, 50ft takeoff distance for mission 2, endurance of 11.8 minutes, $C_{Lmax}$ of 1.75 for takeoff, best rate of climb of 70 ft/sec, and LiPo batteries for propulsion system.

Based on a thorough analysis of all mission characteristics and requirements, the team chose a high-wing stick fuselage configuration from conducting screening and scoring of the main criteria we wanted our aircraft to satisfy. The concept selected also reflects the team's philosophy throughout this project: simplicity and reliability as ways to success.

**Strategy**

The sensitivity analysis revealed that the most important aspect of the scoring came from the ground mission. This mission consists of loading and unloading the passengers for mission 2 as well as loading and deploying the banner for mission 3. We believed that no matter how many passengers we chose, that we would be able to use our engineering minds with a touch of creativity to ensure this mission is accomplished in a timely manner. The next most important part of the scoring came from mission 2 - the passenger payload mission. The scoring criteria for this mission told us that we need to have a high number of passengers, and also a very fast airplane to be successful. We also saw in our analysis that choosing such a strategy for mission 2 would allow us to get a large enough banner to excel in the third mission as well. The final design of our aircraft was designed to carry a payload of around

8lbs, which is equivalent to 24 passengers and luggage; as well as tow a banner that is 60” long at an aspect ratio of 5.

**Aerodynamics**

El Agave was designed with an NACA 4415 on the wing and tail. This airfoil was chosen based on its ability to achieve maximum lift at low angle of attack and the capability of not creating much drag during cruise. This was the selection criteria because maximum lift was needed to take off in 20 feet. The aircraft is also designed for a high cruise speed, so minimizing drag was the second most important criterion; because cruise speed largely affects the scoring for mission 2 and 3. We were able to test a scaled model of our airplane in the 3’x4’ LSWT at Wichita State. The results revealed that with fullspan flaps deployed, we were able to hit our $C_{Lmax}$ value of 1.75 in order to take off in 20 feet. Also revealed was that our $C_{D0}$ value ended up being just over 20% higher than anticipated coming in at a 0.052 after being designed to be 0.042. Performance estimates still show that we will be able to take off in 20 feet as well as achieve a high cruise speed - even though it isn’t the higher cruise speed we designed for.

**Structures**

The structural design of El Agave started by analyzing load paths and creating a flying envelope to determine the maximum load factor that was going to be applied throughout all design faces. High wind gusts, so typical from Kansas’ spring, caused the maximum load factor to have an elevated value of 9.5. El Agave needed to have a big and accessible payload bay to carry the goal of carrying over 8lb of payload. With these two main requirements, the team decided to opt for a stick-fuselage configuration consisting of an aluminum keel beam with a hollow rectangular cross section acting as the main load carrying member of the aircraft. Balsa wood frames were located on critical locations of the aircraft to transfer the fuselage loads to the keel beam. An aluminum frame and nylon screws were used for attaching the main landing gear to the fuselage. The access doors to the passenger bay and to the electronics compartment were thin plastic with tape for weight savings purposes. A semi-monocoque balsa wood design was used for the wing, with an I-beam as the main spar and a circular rod as the secondary spar for attaching and control of the flaps. The empennage was designed in a similar manner as the wing except for the skin panels that were eliminated for weight saving purposes. The full aircraft had a Monokote cover.

**Propulsion**

The propulsion system selection started with determining the power required in different flight conditions such as takeoff and cruise for all three missions. Based on that, a motor and batteries were chosen. The team decided to use different batteries for the missions. Mission 3, the longest mission (10 minutes), required a very large and heavy battery. Mission 2 was only five minutes long and needed a smaller battery. For cost management purposes, the team decided to use the same battery for mission 1 as it was lighter. The battery chosen for Mission 3 is MaxAmps 5S 11,000 mAh. The battery for missions 1 and 2 is the MaxAmps 5S 8,000 mAh. The motor chosen is the E-Flite Power 52 which provides 1650 W and the maximum current is 65 A. This motor was chosen due to its high maximum current. The propeller chosen is the APC 17x10 which provided the needed 9.5lb of thrust.

**Stability and Controls**

The horizontal stabilizer was sized such that the aircraft would have a static margin of 12%. The aircraft did not need to be extremely maneuverable in the vertical direction so the acceptable range for the static margin was 12-20%. The next big S&C design choice was is there a need for flaps. Due to the short takeoff distance that answer was yes. With the designed $\Delta C_L$ given from the aerodynamics lead the aircraft’s flaps were sized as full span flape that had a cord length of 30% of the wing’s chord. The flaps then became flapperons because making them multipurpose saved on weight. After the flapperons were sized the elevator needed to be sized so the aircraft is trimmable both in takeoff and in cruise. The elevator is a full span elevator with a cord of 25% of the horizontal stabilizer’s chord.

**Contact Information**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