AEROSPACE ENGINEERING GLIDER PROJECT

By: Simon Chen & Sami Emmaneni
Class Period: 1B

Due 10/03/23

DESIGN STATEMENT:

Design a glider a for long, stable flight, using the AERY software to evaluate flight performance while specifying dimensions for fuselage, wings, and stabilizers.

CONSTRAINTS

Must be made from:

- One piece of Balsa Wood (Wings and stabilizers) 3/32" x 3" x 12"
- One piece of Basswood (fuselage) 3/16" x 3/8" x 12"

AERY DESIGN SOFTWARE RESULTS:

Aery Evaluation #: 141

Throwing Velocity and angle: 40.0 km/hr, 3.04 degrees

Center of Gravity Location: 8.3 cm

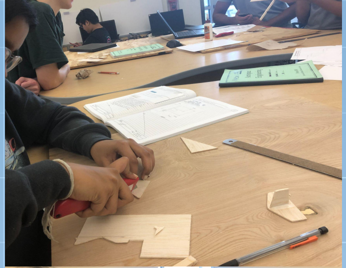
Mass at Nose = 1.43; C_D = 0.021

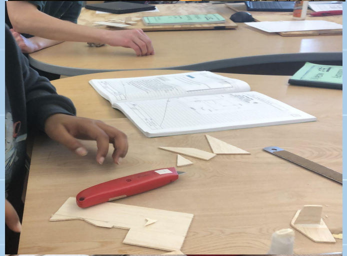
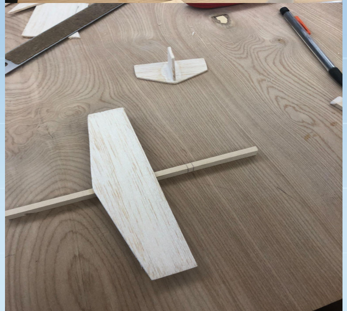
Wing C_L = 4.11; Stabilizer C_L = 2.95

Wing span = 16.00 cm; Aspect Ratio = 4.58

GLIDER DESIGN PROCESS AND DESIGN FEATURES

- Regarding the design of the glider, using only one piece of wood, our glider wingspan and fuselage length couldn't be greater than 30.48 cm, the nose mass couldn't be greater than 30 g, the angle of attack couldn't exceed 4 degrees, and the aspect ratio couldn't be greater than 8.
- Keeping this in mind, to begin with, the glider was set at its max values, and modified from there to achieve an AERY number of over 140. We mainly modified the wings and vertical stabilizer as those were the main things that affected our glider by either decreasing or increasing the AERY evaluation number.
- We noticed that using the sweptback wings compared to the rectangular wings resulted in a higher AERY number, so we kept this as our planform design. This was the same with the wing surface area as an increase in the area created a higher number, however we couldn't exceed 56 cm^2 cause it decreased the AERY number.
- The attributes that contribute to long straight flights are the even distribution of weight and position of the wings and stabilizers. The wing being evenly weighted on both sides helps the glider fly straight and the balance between the horizontal stabilizer and nose mass helps the glider have a uniformed descent. But the vertical tail also plays a major role because it provides the main direction for the glider to travel in depending on its placement.
- To determine what a good CL would be, we mainly paid attention to the angle of attack, and velocity. We kept the angle of attack low and the velocity high to maintain a CL that was optimal for our glider to function successfully.



CONCLUSION QUESTIONS

1) What design or construction techniques enabled gliders for long distance, straight line flight?
A construction technique is to balance around the center of gravity because that helps the plane be mostly stable. Another technique is to trim the wings and nose mass of the glider with small amounts of clay added to either side.

2) What conclusions can you make about optimal glider designs (mention important design features) for long distance flight?
Basing this off of our glider, an optimal glider design that can fly long distance flights successfully usually has a high throwing velocity, low angle of attack, long wingspan, large wing area, and long fuselage length. For a fuselage that was 18.00 cm, over half the maximum length, our glider had a high velocity of 40 km/hr, a low angle of attack of 3.04 degrees, a long wingspan of 16.00 cm, and a large wing area of 55.84 cm^2. Our glider flew a long distance successfully with these features.

3) If your test results were not straight line, stable flight, explain why you think that happened.
At first, the glider flew a straight, stable flight when we had everything balanced correctly. But when we came back the next class period, the plane was not balanced anymore and curved to the left slightly. We suspect that this was because the clay on the nose mass was dry which is lighter now. In addition, we did not have enough time to correctly balance the plane which could have affected the direction it flew in.

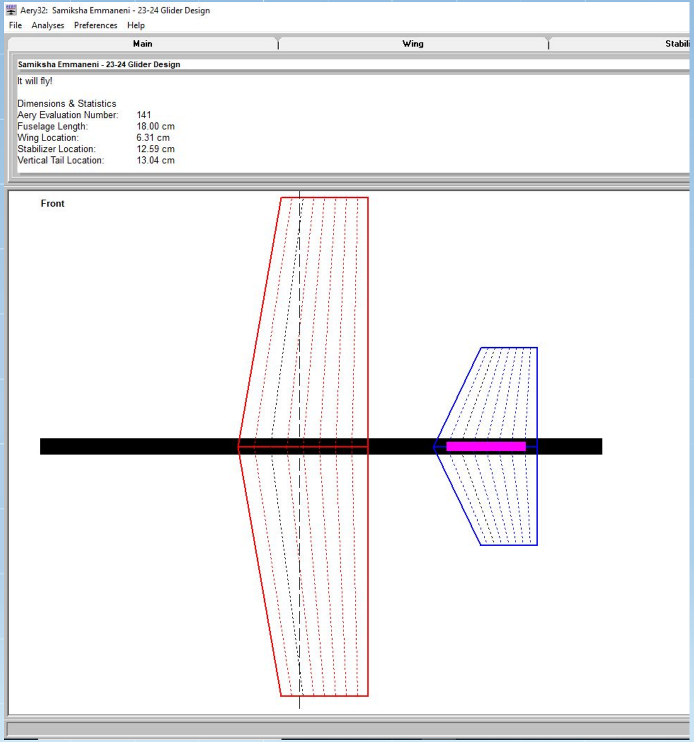
CONCLUSION QUESTIONS (CONT.)

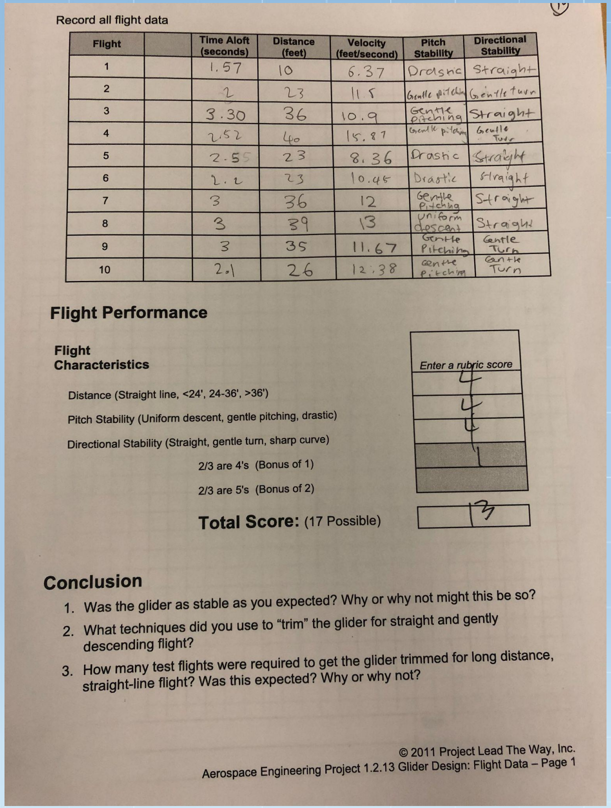
4) How far did your glider travel? Did you time your glider flight and measure the distance traveled? What launch angle did you use? Report the estimated speed (distance / time) and compare to the Aery launch velocity and angle.
The best that our glider flew was 40 feet. We measured the time and and distance traveled for each of our 10 test flights. The range of velocity we got was between 6.37 m/s to 15.87 m/s which is equivalent to a range between 22.93 km/hr and 57.13 km/hr. This works perfectly for our AERY launch velocity of 40.00 km/hr as it's between that range. The launch angle we used when testing was around 3 degrees which was the same as our AERY launch angle of 3.04 degrees.

5) What is the lift formula and which variables were part of your Glider design and testing.
$L = (C_L * A * \rho * v^2) / 2$. The coefficient of lift, area of the wing, and velocity were all part of our glider design and testing.

6) What would you do to improve your design or flight performance?
When we were testing, it was curving a little, so we smeared some clay on the right side of the glider. However, we underestimated the effects of the clay, as it caused the glider to turn to the right too much. To improve our design to make it fly straighter, we could either add more clay to the left side or remove some from the right, however we didn't have much time to balance and test this out. This leads to the next possible improvement of spending more time testing to make smaller adjustments and balance the glider better.

FLYING AIRPLANE THEME INFOGRAPHICS





Record all flight data

Flight		Time Aloft (seconds)	Distance (feet)	Velocity (feet/second)	Pitch Stability	Directional Stability
1		1.57	10	6.37	Drastic	Straight
2		2	23	11.5	Gentle pitching	Gentle turn
3		3.30	36	10.9	Gentle pitching	Straight
4		2.52	40	15.87	Gentle pitching	Gentle Turn
5		2.55	23	8.36	Drastic	Straight
6		2.2	23	10.45	Drastic	Straight
7		3	36	12	Gentle Pitching	Straight
8		3	39	13	Uniform descent	Straight
9		3	35	11.67	Gentle Pitching	Gentle Turn
10		2.1	26	12.38	Gentle pitching	Gentle Turn

Flight Performance

Flight Characteristics — *Enter a rubric score*

Distance (Straight line, <24', 24-36', >36')	4
Pitch Stability (Uniform descent, gentle pitching, drastic)	4
Directional Stability (Straight, gentle turn, sharp curve)	4
2/3 are 4's (Bonus of 1)	1
2/3 are 5's (Bonus of 2)	

Total Score: (17 Possible) 13

Conclusion

1. Was the glider as stable as you expected? Why or why not might this be so?
2. What techniques did you use to "trim" the glider for straight and gently descending flight?
3. How many test flights were required to get the glider trimmed for long distance, straight-line flight? Was this expected? Why or why not?

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