AE 705: Introduction to Flight

Group Assignment: 03

CHUCK GLIDER COMPETITION REPORT

Team 7

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Introduction:

Objective: Each team will fabricate glider(s) and launcher(s) to meet the following requirements when launched from the third floor of the Lecture Hall Foyer, located beside Shiru Café on the first floor

- **Range:** The glider should aim to hit the Shiru Café entry structure on the opposite side. If it does not, it should maximize the net distance traveled (Range), which is the total distance covered minus the lateral deviation from a straight line path to the point of contact. The glider must pass between the two pillars. If it hits the pillars or flies out of bounds, a penalty will be imposed, reducing the 'range score' by half.
- **Endurance:** The glider should maximize the total time it stays airborne (Endurance), i.e., the time between launch and when it hits any object.

Design Approach: We will use Aerodynamic Principals to design gliders for Range and Endurance.

Design Specifications

Airfoil and Dimensions for glider

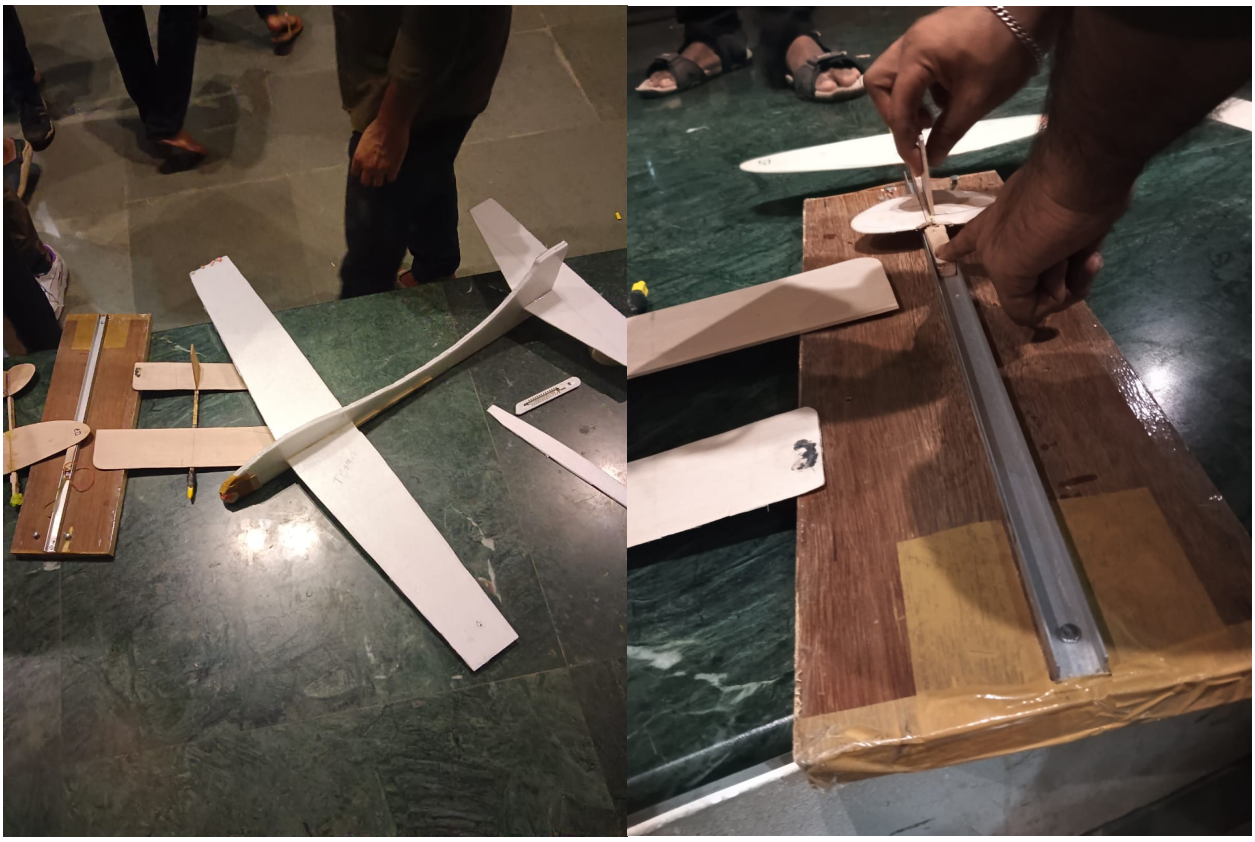
1. **For Range**
2. **For Endurance**
3. **Materials Used**

Design and Assembly of Gliders

Step by step procedure for making Gliders This updated report focuses on the comparison and analysis of three distinct gliders—one foam-based glider, one with a rectangular wing balsa wood design, and one with an elliptical wing balsa wood design. The objective remains to optimize these gliders for long-range flight and endurance

1. **Material and Design Considerations:**
   - **Foam Glider:** Used Depron sheet to make this glider
   - **Rectangular Wing Balsa Wood Glider:** For Range we Used balsa wood to make rectangular wing glider.
   - **Elliptical Wing Balsa Wood Glider:** Again Used Balsa wood to make Elliptical wing for Endurance
   - **Launcher:** For launcher we used wooden fly board with metallic pipe which is used to launch
2. **Dimensions For each Gliders**

Glider Component	Foam Glider	Rectangular	Elliptical
Wing Span(cm)	120cm	25cm	28cm
Chord Length(Wing)	16cm	7cm	8cm
Fuselage Length	87cm	17cm	20cm
Horizontal Tail span	25cm	8cm	6cm
Horizontal tail chord	8cm	3cm	4cm
Vertical Tail height	20cm	6cm	6cm



Gliders For Range

For this assignment, we were tasked with designing and building gliders that could achieve maximum range while flying straight and true. We experimented with many designs, including 3D-printed gliders. However, the 3D-printed models were too small, and increasing their size significantly added to their weight, making them impractical. As a result, we decided to stick with balsa wood.

We tested a variety of designs, starting with a fuselage made of two long rectangular strips glued together for added strength, and a notch in the forward section to attach the glider to the launcher. However, we found that the notch interfered with the launch, reducing the glider's momentum. As a result, we discarded this approach and modified our launcher. We opted for a simple catapult-style launcher that pushed the glider from behind, which improved performance significantly.

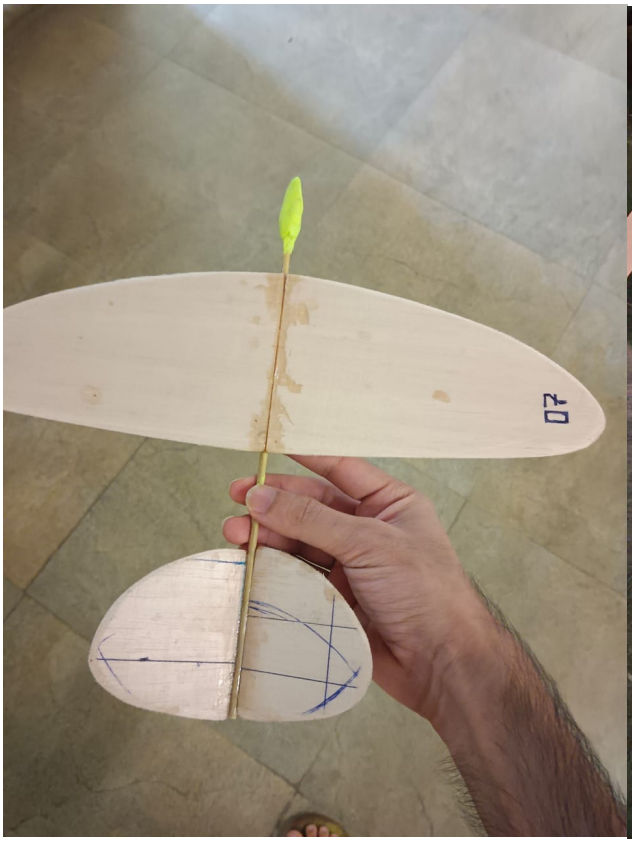
We also experimented with different wing shapes, including straight rectangular, elliptical, and swept wings. After extensive trial and error, we discovered that a rounded rectangular wing, combined with a simple rounded rectangular horizontal tail and vertical tail (VT), flew the farthest and maintained a straight flight path. Additionally, we modified the fuselage design, replacing the earlier structure with a simple pointed bamboo stick, which further enhanced the glider's range and stability.

Foam Glider For range

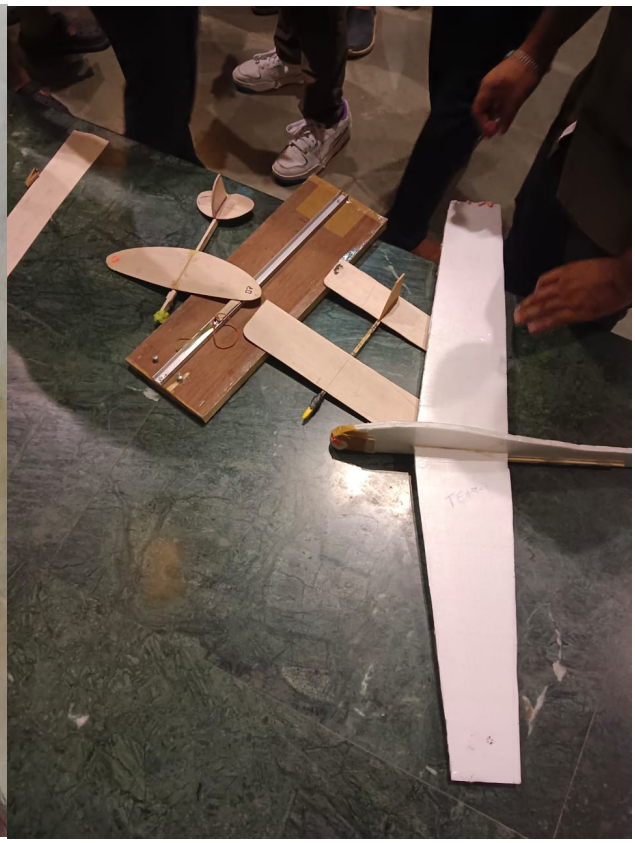
Balsa Gliders for Range

Gliders for Endurance

Endurance of a glider refers to the maximum time it can stay afloat in air. It would mean minimizing the sink rate for a given glider mass and launch velocity. Sink rate depends directly on how heavy the glider is, and the lift it generates. A heavier glider would ofcourse sink fast, reducing the endurance for a given lift force. Also, it would require higher lift for a glider to stay afloat for a given glider mass.
Therefore, our design begins with minimizing the glider mass. For a typical glider design, lighter materials such as balsa, styrofoam or depron are considered. Efforts are put to minimize structural reinforcements by suitable designs of fuselage and wing joints. The team prepared the stencils for fuselage, wing, vertical and horizontal tail, and then cut the parts from balsa and styrofoam.
Initial assembly was made using fewikwik and fibretape. To check structural strength, initial flights were carried out, and appropriate reinforcements were added at wing fuselage and horizontal tail fuselage joints
Wing design was kept as elliptical so as to achieve maximum aerodynamic efficiency.
Trials of glider made with balsa, styrofoam and depron were carried out. Team found the best performance of depron glider in terms of maximum endurance. Team practised a lot, and worked out suitable launcher designs.



Elliptical Wing Glider for Endurance



Foam Gliders For Endurance

Launcher

This setup demonstrates a simple and efficient pusher-type glider launcher mechanism designed for launching small-scale gliders. The launcher consists of a wooden base with a guiding rail, onto which the glider is mounted. The glider features a foam and balsa wood frame to provide both lightness and stability during flight.

Components:

Launcher Base: The main structure is a wooden platform equipped with a metal rail. The rail ensures smooth and guided motion as the glider is propelled.

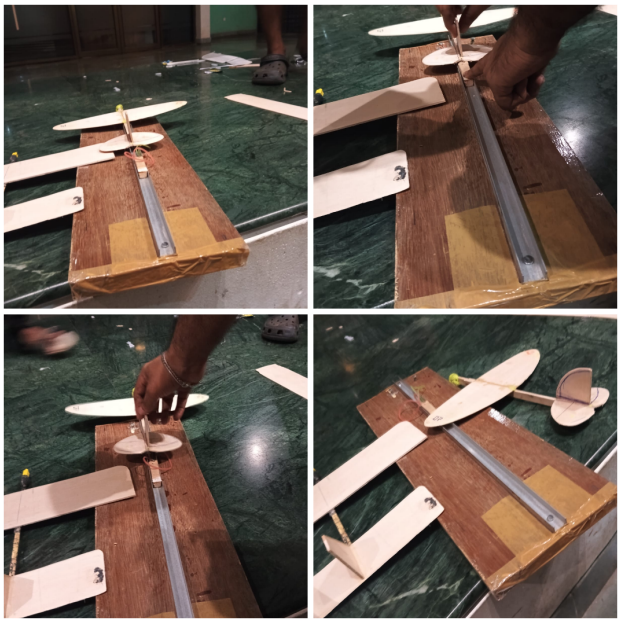
Pusher Mechanism: A small rubber band is attached to a sliding component on the launcher. When released, the tension from the rubber band generates thrust, pushing the glider forward along the rail.

Glider: The glider itself features a light airframe made of balsa wood and foam. The wings are crafted for minimal drag, providing longer flight durations and more stable trajectories once airborne.

Working:

The launcher operates by pulling back the rubber band, which is attached to the back of the glider. Upon release, the elastic energy stored in the band propels the glider along the rail at sufficient speed to achieve liftoff. The smooth guiding rail ensures a straight trajectory during the launch, improving the precision and consistency of flights.

This design simplifies the launch process, allowing for repeated tests and adjustments to the glider's performance. Ideal for educational and competitive purposes, this launcher provides insights into basic aerodynamics, forces, and the mechanics of flight.

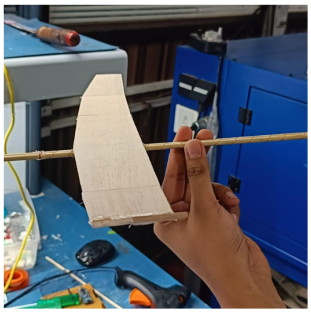


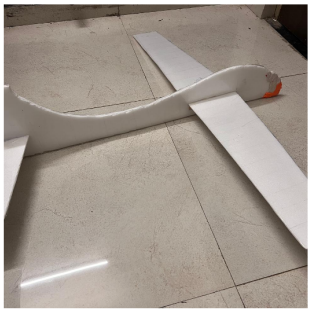
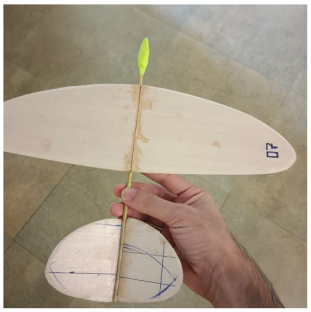
Launcher For Gliders

Testing Gliders on Launcher

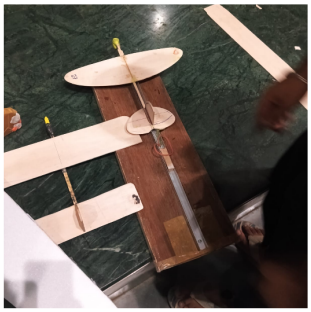
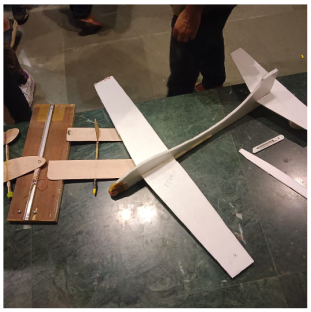
Trial and Testing Documentation

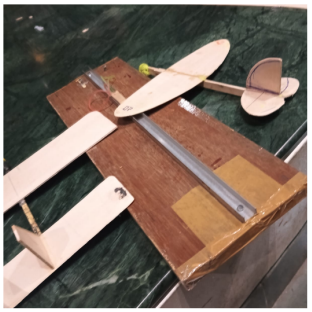
- **Trial 1:**
  - After Assembling the Foam glider see if it can glide but it stalled after throwing.
  - Our next task was to balance CG by adjusting or adding weight at Nose of the glider
  - Again We tested after few hit and trial we finally manage to it and It started to glide at low AOA
  - This glider we made for both Range and Maximum endurance
  - **We got Endurance for this Foam glider in Final testing 8 sec** and It also it the wall of Shiru cafe at Lecture hall foyer
- **Trial 2:**
  - After Assembling the Balsa wood Elliptical Wing glider see if it can glide but it stalled after throwing.
  - Our next task was to balance CG by adjusting or adding weight at Nose of the glider
  - This glider we made for the purpose of endurance to increase maximum time in air
  - Again We tested after few hit and trial we finally manage to it and It started to glide at low AOA
  - **We got Endurance for this Balsa wood elliptical glider in Final testing 9 sec** but we didn't record that video after that we only got 6 sec of endurance
- **Trial 3:**
  - After Assembling the Balsa wood Rectangular Wing glider see if it can glide but it stalled after throwing.
  - Our next task was to balance CG by adjusting or adding weight at Nose of the glider
  - This glider we made for the purpose of Range to increase maximum distance
  - We adjusted AOA at which glider should be released so that it can glide to Maximum distance we found out at 1 deg or 2 deg it goes to maximum distance we didn't found out exact angle but from launcher it was pretty clear.
  - **We got Maximum Range for this Balsa wood Rectangular Wing glider as it Hit the target** but there was some deviation of 8 feet from the target but it reached at the end.
- **Trial 4:**
  - After Assembling the Balsa wood Swept tapered Wing glider see if it can glide but it stalled after throwing.
  - Our next task was to balance CG by adjusting or adding weight at Nose of the glider
  - This glider we made for the purpose of maximum Range to increase maximum time in air
  - Again We tested after few hit and trial we finally manage to it and It started to glide at low AOA
  - **We got Endurance for this Balsa wood elliptical glider in Final testing 4 sec** so we decided that we will not use it for testing in Final trial
- **Launcher Testing:**
  - After testing with hands our next task was to launch through Launcher
  - After testing Each glider 4 gliders that we made we decided we will use Rectangular wing and Foam Glider For Final testing
  - We were getting Maximum Range and Maximum Endurance Using Rectangular Wing and Foam Glider
- **Link For Videos of Testing**





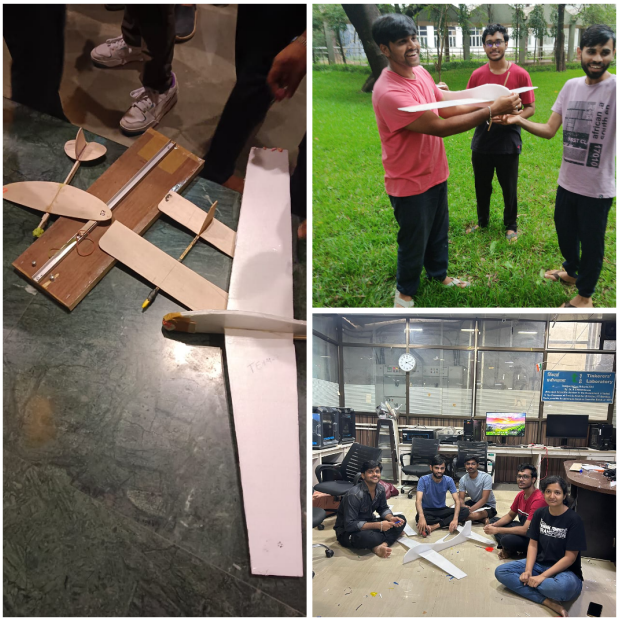






Conclusion

It was a long and enjoyable process. In the beginning, we spent about a day deciding on the design and materials for the glider. Initially, we planned to use only Styrofoam to build gliders for both range and endurance, but later switched to balsa wood and depron sheets. The rectangular-wing glider was easier to construct and provided stable, reliable flight, though it had higher drag. Meanwhile, the elliptical-wing glider, while more complex to build, demonstrated superior aerodynamic efficiency and endurance, making it highly effective for long-range performance. Additionally, we built a larger glider with a longer wingspan using depron, which also offered good endurance characteristics. Ultimately, we decided to use both the elliptical-wing glider and the depron glider in the two separate endurance trials, combining the strengths of each design to optimize performance across different conditions.

Glider



Glider with Launcher