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Director of The STEMAZing Project

Engineering the World's Best Glider using IDEAS Engineering Journal

(Adapted from: https://www.exploratorium.edu/science_explorer/hoopster.html)

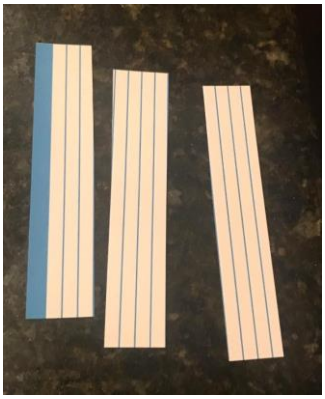
Materials

Scissors*
Ruled 3x5 Index Cards*
Clear Plastic Tape*
Thin Flexible Plastic Straws*
*Required Materials

Optional Additional Materials
Straws of varying sizes
Other kinds of paper
String
Different kinds of tape
Other materials for modifications

Teacher Preparation

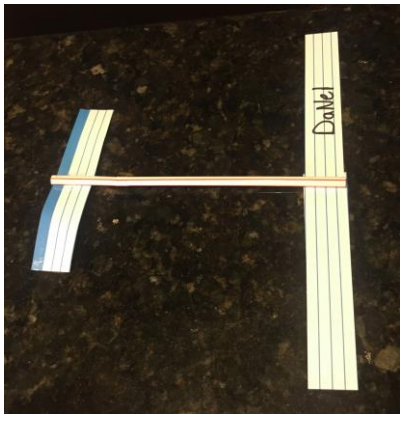
Either print hard copies of the IDEAS Engineering Journal (http://bit.ly/IDEASEngineeringJournal) or assign students a copy of the IDEAS Engineering Journal Virtual Edition using Google Slides (https://bit.ly/IDEASEngineeringJournalVirtual).



You may want to use one of the presentation versions (PowerPoint, PDF, or Google Slides) to help walk students through the construction of the original design and first modification. These are all available here: http://bit.ly/EngineeringWorldsBestGlider

Minimally each student will need about 10 index cards, a roll of clear plastic tape, and about 10 straws.

Build Original Glider Design with Students



Be sure to talk up this design as being the world's best glider. Mention how impressed you think they are going to be with the design and how well if performs.

STEP 1: Cut an index card the long way into three equal strips. For ruled index cards, this will correspond to cutting on every 4th line, as shown to the right.

STEP 2: Overlap two of the strips by about a quarter of an inch and tape around them to make a double length strip.

STEP 3: Tape the straw to the middle of the single strip and the double length strip as shown to the right.

STEP 4: Add student name to the long strip as shown.

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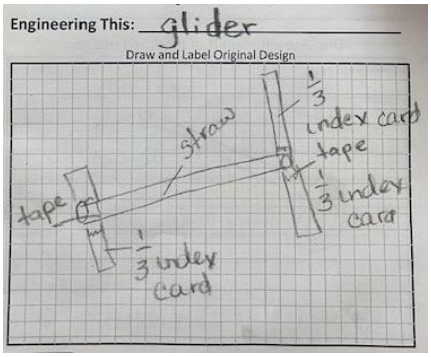
STEP 5: Draw and label the diagram of this original design in your IDEAS Engineering Journal.



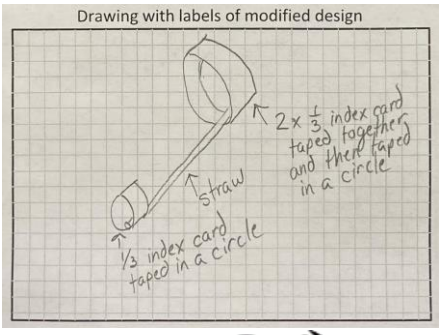
STEP 6: Fly the airplane numerous times to see how it works! NOTE: You will want to make sure you wait for everyone to test the design at the same time. When it doesn't work so well, have them try throwing it with the other wing in the lead, a little harder, a little softer. See if they can get it to fly all the way across the room. There is usually one that will fly well but many. Most will fly for a bit, stall, and fall to the ground.

Depending on how much time you have, you may also want students to throw the original glider 5 times in the orientation they think works best and measure how far it goes each time.

NOTICE BREAK: What do you notice?

- The airplane does not fly that well.
- It won't go very far.
- It doesn't matter if you try to fly it with the short wing first or the long wing first, it is not that great.

STEP 7: Have students brainstorm modification ideas using the questions provided in the IDEAS Engineering Journal for Modification 1. You may want to focus them on the question, "Can you change the shape of a part?" Students should record their ideas in their journals.



STEP 8: Now bend the strips into loops, overlapping the ends by a quarter of an inch, and tape around them, as shown to the right.

STEP 9: Draw and label the diagram of Modification 1 in your IDEAS Engineering Journal. Complete the description of the modification and why it was picked. Students might use, "The teacher told me to do this."

STEP 10: Fly the airplane numerous times to see how it works! NOTE: You will want to make sure you wait for everyone to test the design at the same time. You can either give them the hint that they should throw it with the small loop facing forward or let them discover that on their own.

Depending on time, you can have them fly the two looper five times and measure how far it goes.

Picture from Exploratorium website listed at top of page.

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NOTICE BREAK: What do you notice

- The airplane flies MUCH better! Engineers should be able to get it to fly across the room now.
- Sometimes the Two Looper Airplanes will spiral as they fly through the air and other times they simply glide without turning at all.
- It definitely flies better when you have the smaller loop facing forward.
- If you fly it with the straw starting on top, it will rotate so the straw is on the bottom.

STEP 11: Engineers should now officially assess the performance of the glider with the two loop modification. Circle or highlight either Better / Same / Worse and then describe how they know in the evidence section. They may sight qualitative data if they measured different trials of the original and two looper designs or they can use observational data. They can then select if they are going to Keep / Kick the modification.

STEP 12: Let them engineer on their own! Now they can complete modification on their own while filling out the journal. They are asked to let someone else test their design after the third modification. This can either be done by other engineers in the room or at home with a significant adult, sibling, or neighbor as the tester.

STEP 13: Students can share their final designs with the class. If you want to incorporate technical writing, students could be required to upload their final design directions to a site like Instructables, or model that format, so others can construct their BEST final design.

STEMAZing Picture Book Recommendations: *Violet the Pilot* by Steve Breen, *I am Amelia Earhart* by Brad Meltzer, *Going Places* by Peter H. Reynolds, or any other book about pilots and airplanes.

Connections to the activity: Airplanes, Engineering Design Process, Persistence, Grit

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What the heck? Explanation of the Science

The four forces of flight are working on any flying object. Those forces, shown to the right, are weight, lift, thrust, and drag. For a glider like the Two Looper Airplane, thrust is provided as the airplane launched. Once it is gliding, there are only three forces acting on it, because thrust is no longer being applied.

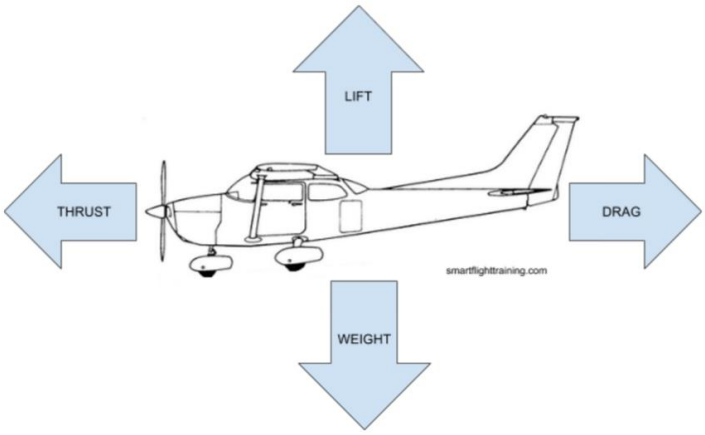

Image from: https://smartflighttraining.com/beginners-series-four-forces-flight

Although there are many different paper airplane designs, almost all of them have a flat winglike structure, which, like a traditional plane, helps create lift to keep the plane in the air. For something to glide through the air, there must be a balance between gravity pulling the glider down and the lift produced as it glides through the air. The plane in this activity gets the lift, or upward directed force, needed to glide from the two loops, instead of flat wings. At the same time, gravity is pulling on the airplane with a force we call weight. The weight of the airplane is trying to pull it down but at the same time lift from the air acting on the two loops holds the airplane up.

Drag is a friction force created as the Two Looper Airplane tries to cut through the air. This force works in the opposite direction the airplane is moving, so it slows it down. This eventually results in the airplane falling back to the ground because, as a glider, it doesn't have an engine to provide the thrust needed to keep it in the air. Normal wings have wing tips that generate vortices, adding drag (which isn't ideal for an object trying to stay aloft). The lift-providing loops have no wing tips and so they have less drag. The streamlined shape of the Two Looper Airplane also makes it easier to throw accurately.

Explanation Adapted From: https://www.scientificamerican.com/article/loop-the-loop-with-a-flying-hoopster/