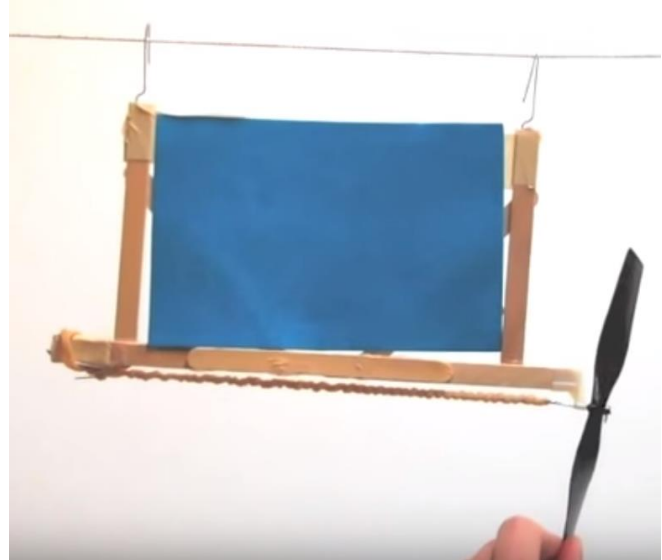


# Propeller-Powered Zipline Racers

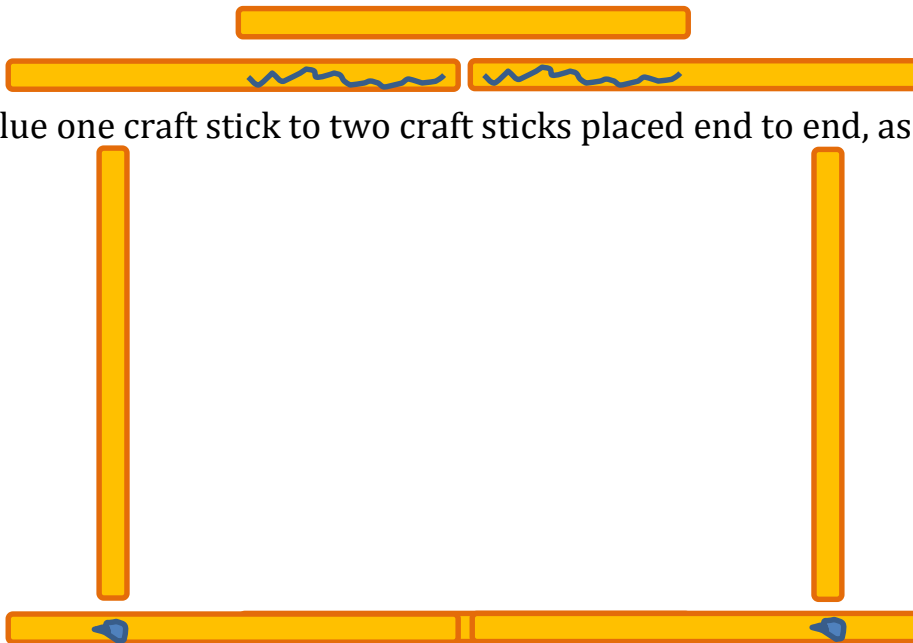
Adapted from: <http://www.instructables.com/id/Propeller-Powered-Zipline-Racers/>  
A project from The Workshop for Young Engineers (<http://thewye.com>)

## Materials

- 7 craft sticks
- 3 paperclips
- 1 hook nose propeller
- 1 4x6 index card
- 2 rubber bands
- masking tape
- hot glue gun and glue
- fishing line
- scissors

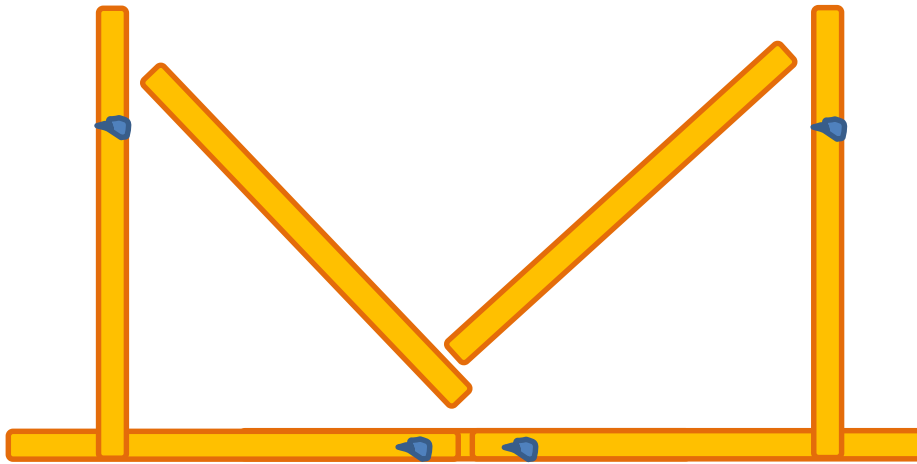


## Step 1: Building the frame.



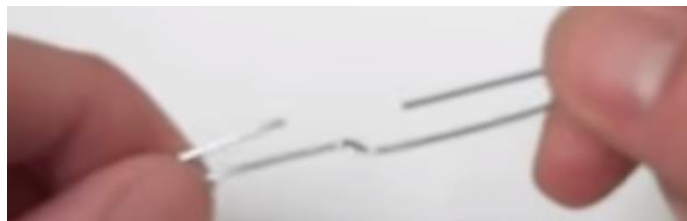
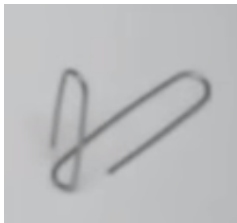
Hot glue one craft stick to two craft sticks placed end to end, as shown above.

Glue two more craft sticks to either end of the base you just made, as shown above.

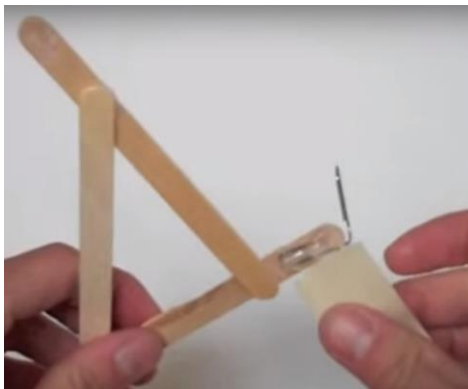


Using two more craft sticks, glue braces on either side of the frame, as shown above.

Take three paper clips. Bend one open into an L shape, as shown below. The other two need to be bent open all the way flat and then twisted 90°, as shown below.



Attach paper clips to frame using hot glue and tightly wrapped masking tape.



The L shaped paper clip goes on one end of the frame, as shown to the left.

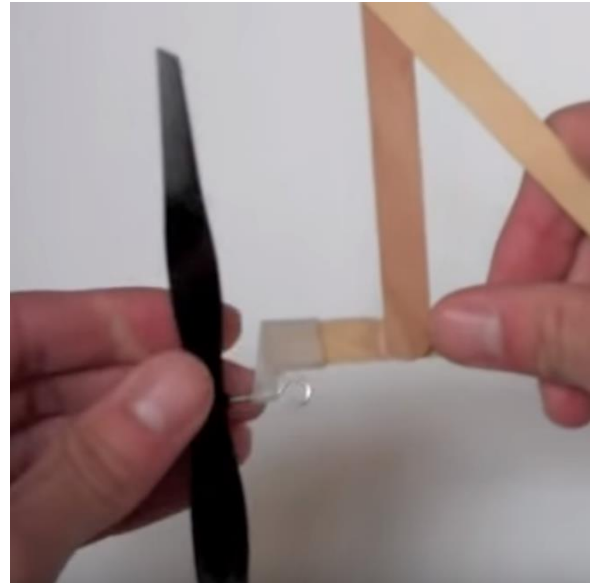


Glue the long, twisted paperclips to the top of the frame, as shown to the left.

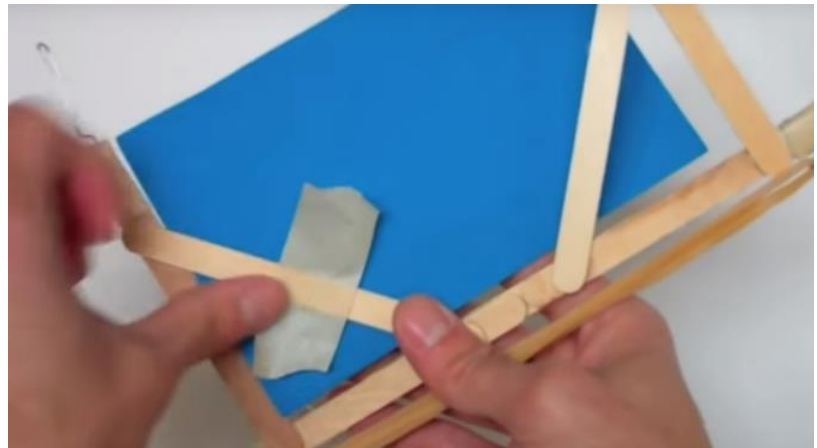
**NOTE:** Be sure the hooks are facing the same direction.

Put the propeller on with the hook on the underside of the frame.

Connect rubber bands from the propeller hook to the paperclip.



Tape an index card to the frame using a couple pieces of tape, as shown to the right.



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## Zipline

Secure a length of fishing line (make sure it is taut) across the room. Let students wind up their zipline racers and watch them zip along the line!

### How It Works

It's simple. Winding the propeller will store energy in a rubber band by twisting it. When released, the propeller rapidly unwinds and generates thrust, which pulls the craft along a low-friction zipline. However, the torque from the unwinding propeller can cause the entire racer to flip upside down. To counter this force, another force is introduced: drag. By attaching a paper cutout, drag perpendicular to the side of the racer is created, which helps prevent inversions.

### Safety and Tips

- CAUTION! Pulling downward on the racer while it is hooked onto the zipline may cause it to be flung off the line upon being released. This can be dangerous when the propeller is rapidly unwinding. Be sure to directly supervise each student at least once as they attempt to launch their racer for the first time. Be sure to correct anyone who pulls on the zipline before a launch.
- Make sure the zipline is either highly visible or above everyone's head.
- Young students (grades 1-3) may need extra guidance while bending the paperclips, attaching the rubberbands, and properly launching the racer.
- Encourage your students to experiment to find innovative improvements and modifications to the zipline racer!