



Circuit Playground Express Sugar Glider

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<https://learn.adafruit.com/cpx-sugar-glider>

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Overview



In this guide we'll build a descent vehicle of the sort you might see on a documentary about JPL landing probes on Mars, though nothing so elaborate as the Sky Crane that was used for Curiosity's entry and landing. We'll use a Circuit Playground Express to control a couple small, lightweight servos to deploy wings that will slow its fall.

What's cool about the Circuit Playground is it has an **accelerometer** built in, a sensor that can detect motion/movement/tilt. It has the ability to detect when it is in free-fall (gravity is an acceleration!) and when it's still. This lets you deploy the wings automatically!

The device is simple and very much a proof of concept, but the idea can be used as inspiration to do something more elaborate. Hey, even JPL starts with a proof of concept!

This project uses MakeCode for the Circuit Playground Express. If you're not familiar with MakeCode, there's [an introduction in the Circuit Playground Express guide \(https://adafru.it/AQW\)](https://adafru.it/AQW).



Parts List

1 x [Circuit Playground Express](https://www.adafruit.com/product/3333)

<https://www.adafruit.com/product/3333>

Circuit Playground Express is the next step towards a perfect introduction to electronics and programming.

2 x [Micro Servo](https://www.adafruit.com/product/169)

<https://www.adafruit.com/product/169>

Small, light, 180 degree servo.

1 x [Lithium Ion Polymer Battery](https://www.adafruit.com/product/328)

<https://www.adafruit.com/product/328>

3.7v 2500mAh LiPo battery. This provides power as well as acting as a counterweight.

1 x [Premium Male/Male Jumper Wires](https://www.adafruit.com/product/758)

<https://www.adafruit.com/product/758>

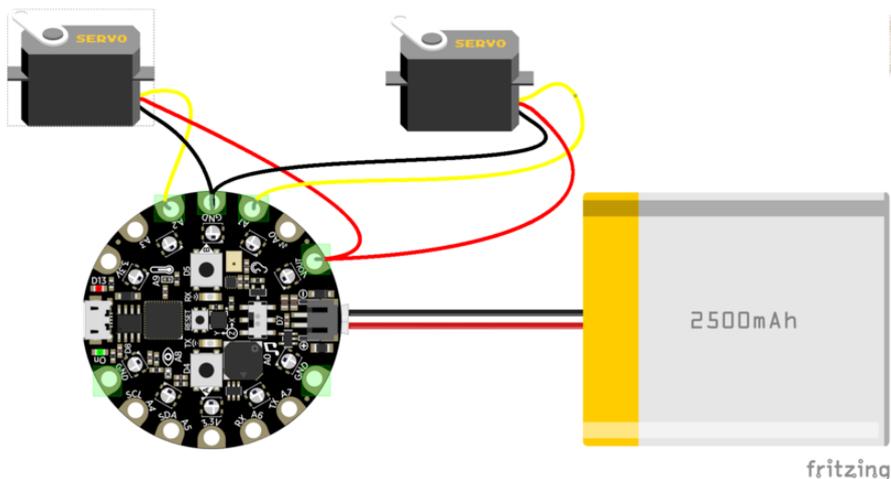
We'll use 3 wires from this, ideally with colors matching the wires on the servos.

Tools and Supplies

- corrugated cardboard
- thin bamboo skewers
- plastic shopping or garbage bag
- hotglue and glue gun
- small zipties



Wiring



The circuit for this project is straight-forward. The two servos are connected to the Circuit Playground Express, via pads **A1** and **A2**.

You could use alligator clips to connect to the pads, or M3 nuts and bolts. The problem with both those is that they add more weight!

Just as with a planetary probe descent system, every bit of extra weight must be compensated for by the descent system. With this in mind, the connections to the servos can be made with the jumper wires (that plug into the servo cable's connector) soldered directly to the pads.

You can use a desoldering braid later to remove the solder and use your Circuit Playground Express with clips or a CRICKIT again.

You can take weight reduction to an extreme if you like (and go for the full JPL experience): trimming and soldering the wires from the battery and servos directly to the pads in an attempt to shed the weight of the extra wire and connectors. That's getting a bit excessive, though. Especially if you want to use the parts for other projects in the future.

Construction

Prep the Base



Start by cutting a rectangle of cardboard: 10cm (4") by ~18cm (7") works well. It's best if it's cut so that the corrugations run along the length of the piece. Mark a center line lengthwise, which will be used later to center the Circuit Playground Express and battery. Also mark a line across the piece, about 1 cm from one end.



Measure the body of your servos and mark two rectangles slightly smaller, near the edge (5mm - 3/8" in the image here). For the servos listed, 12mm (4 3/4") by 22 (8 7/8") mm works well or trace them out. The goal is to have the servos fit very snugly into the holes. Carefully cut them out.

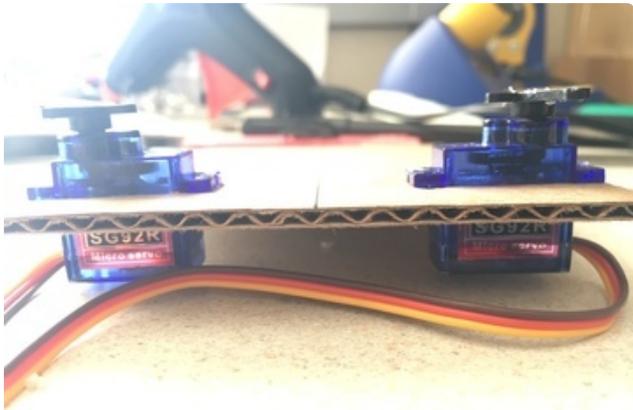


When you're marking something like this with areas to be cut out, it can be useful to mark the areas to be removed as was done here.

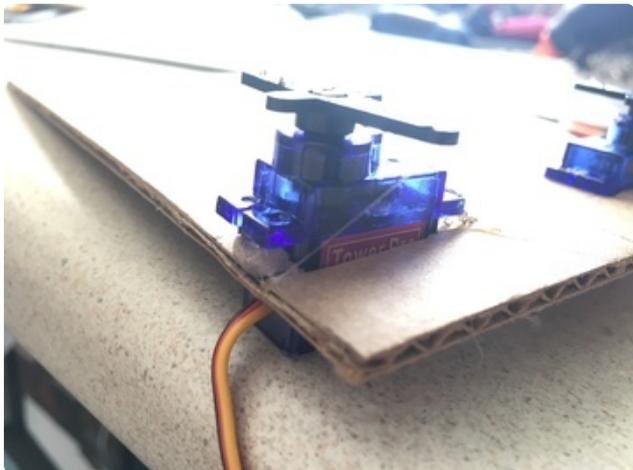
Mount the Servos



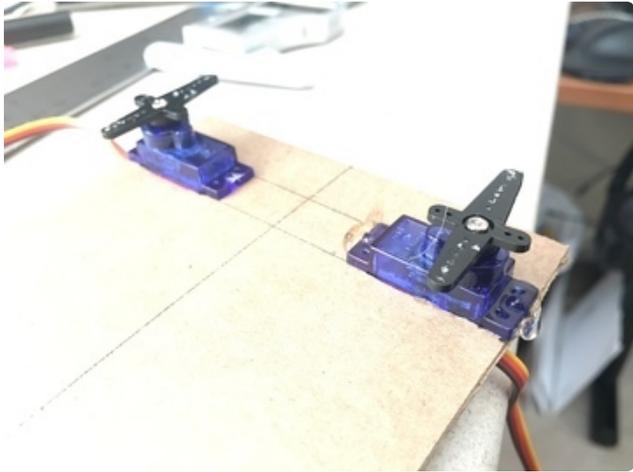
Carefully (very carefully) push the servos into position. The output shafts need to be closest to the edge.



Make sure they fit all the way in with their mounting flanges flush against the cardboard.



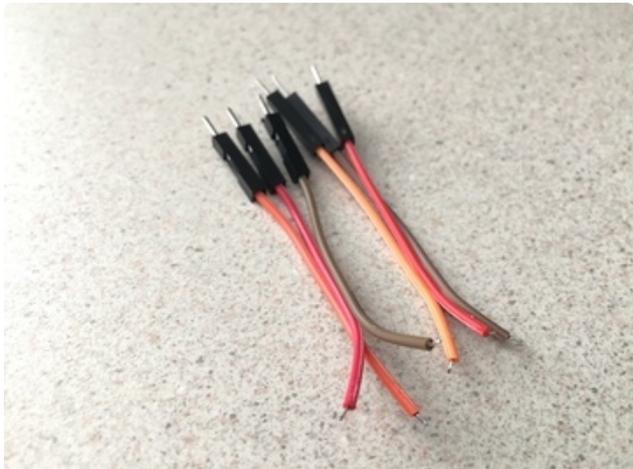
Back the servos out a little and squirt some hot glue on the cardboard under their mounting flanges. Then slide them back into position. Because of the snug fit you just need a little glue to hold them in place.



Prepare the Servo Wiring

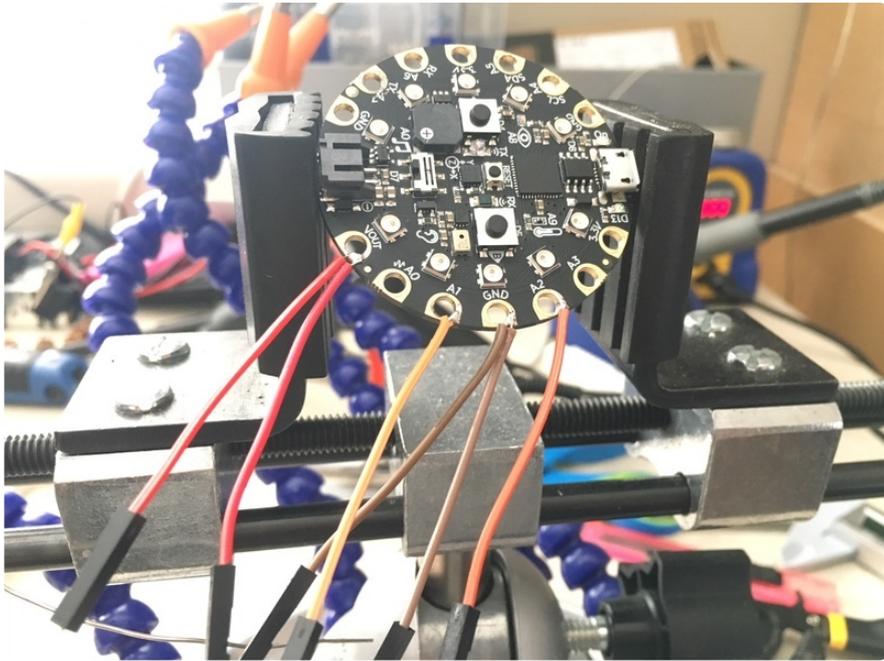


Take 3 Male/Male jumpers in colors that match your servo wires. This just makes it easier to connect them later. Cut a 4-5 centimeters (2") from each end.

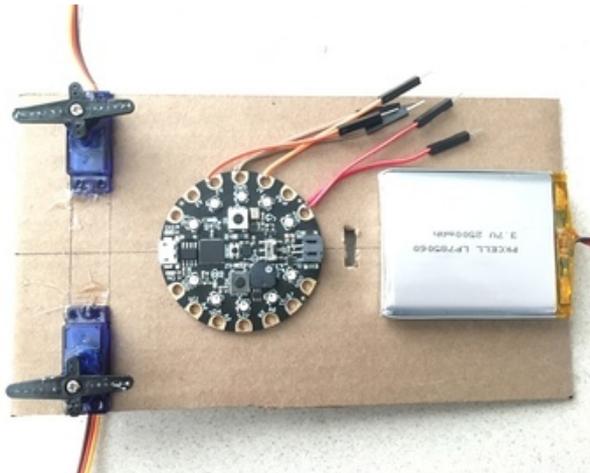


Strip and tin the ends. Then carefully solder them to the appropriate pads on the Circuit Playground Express.

In this case brown is ground, red is power (Vout), and orange is the PWM signal. This matches the micro servos used.

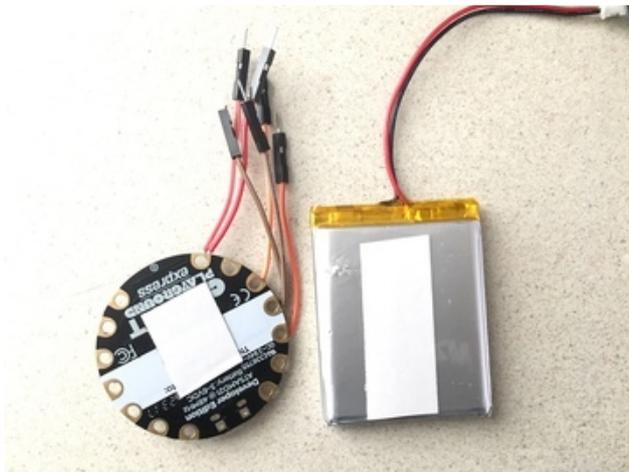


Mounting onto the Base



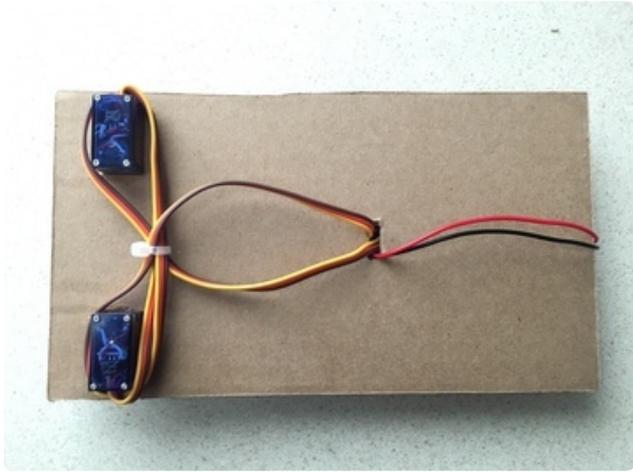
Place the Circuit Playground Express and battery on the base as shown. The battery should be as near the "back" end as possible. Leave some room between it and the Circuit Playground Express for wiring. Mark and cut a small slot between the two, big enough for the battery and servo connectors to be fed through.

When positioning, the battery cable must be able to reach under the base, through the hole, and into the Circuit Playground Express's battery connector.



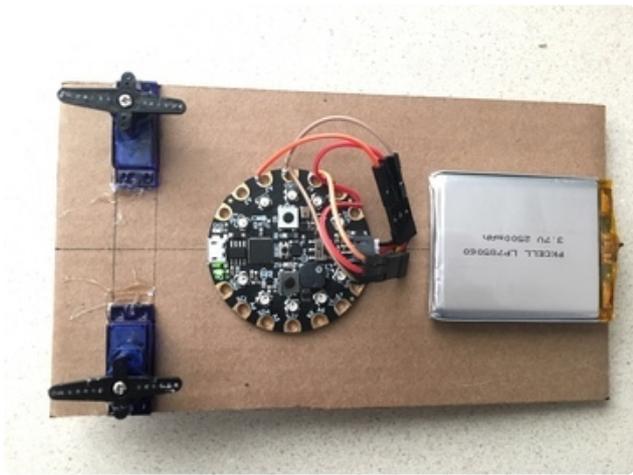
While a smaller battery would work and weigh less, the larger one was found (through trial and error) to better balance the glider. Even with the additional weight, this improved overall performance by preventing an immediate nose-dive due to the servos at the leading end.

Add a piece of double sided tape to the the Circuit Playground Express and battery. You really just need enough to hold them in place.



Loop the servo wires around the servo bodies and secure with a zip tie (or wire twist-tie, or bit of string... it's not important what) to keep them tidy and out of the way.

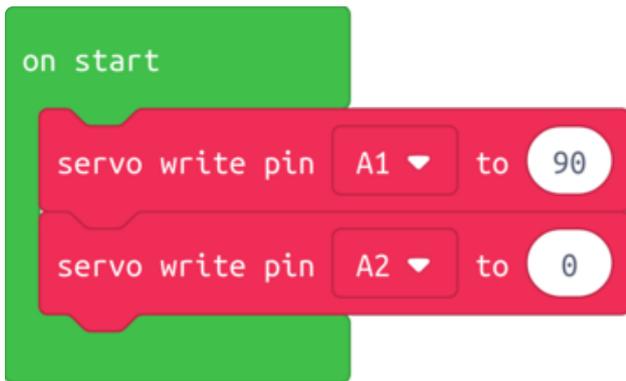
This should leave enough length to go through the hole you cut between the Circuit Playground Express and battery. Similarly, the battery wire should go along the underside and through the hole.



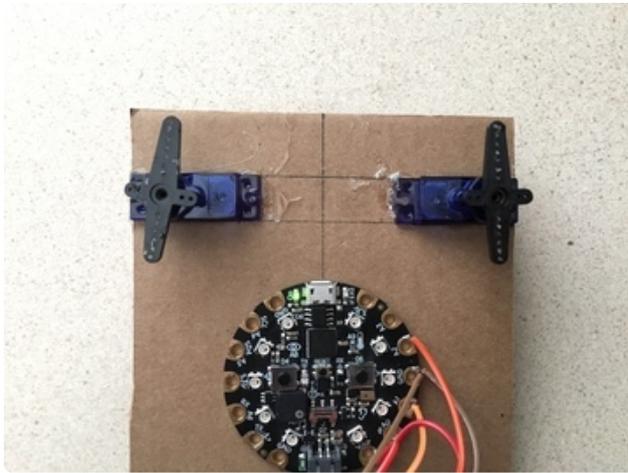
Secure the Circuit Playground Express and battery in place, and connect the wiring.

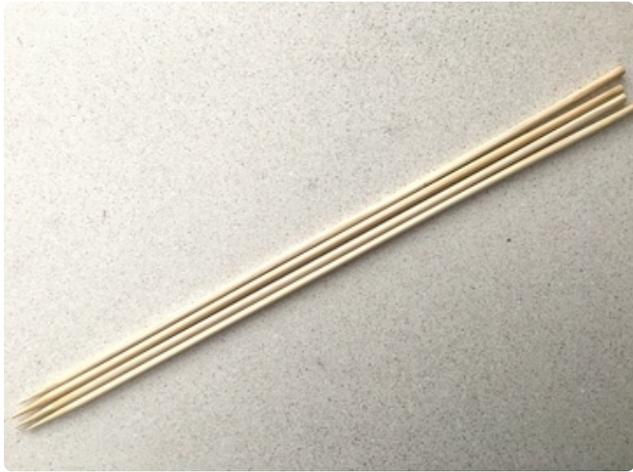
Connect the servo at the bottom of the last photo to A1, and the one at the top to A2.

Making the Wings



Use the code on the left in MakeCode to set the servos to rest position. Mount the longest servo horns as shown. The `servo write pin` block is under the **PINS** block group which you can chose from if you click the black **ADVANCED** block first.



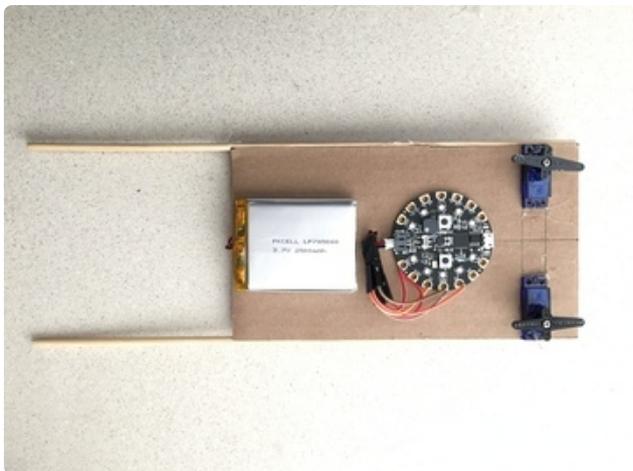


Select 4 skewers that are reasonably straight and cut them to the same length. These will probably be around 30cm long, so just cut the point off as we want them as long as we can get (within length) since their length determines the area of the wings, and thus their effectiveness.

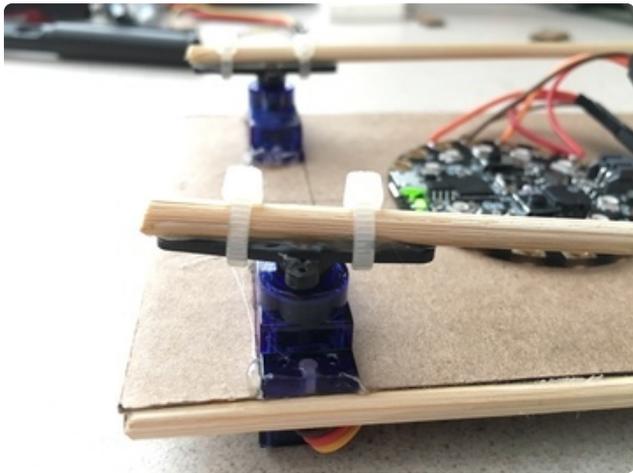
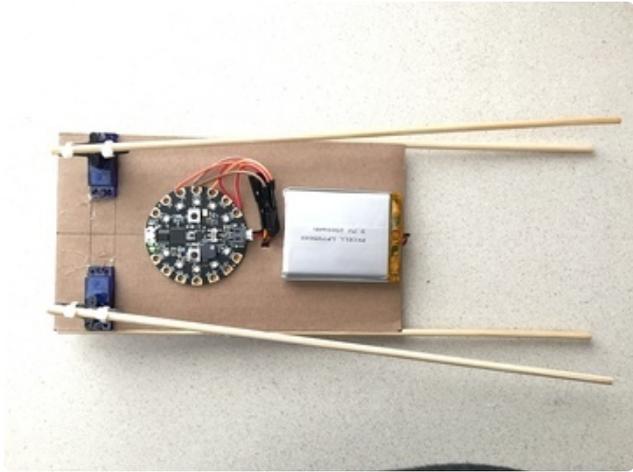


Run the end of a skewer along the long edges of the base to make a channel that a skewer can nestle into.

Hot glue a skewer into each of those edge channels so that they are flush with the end near the servos and extend past the end with the battery.



Hot glue the other two skewers to the servo horns so that they extend alongside the skewers that you glued to the base. Using hot glue with the slick plastic the horns are made of did not inspire confidence, so adding a couple zip ties to each servo horn seems to be a good idea.



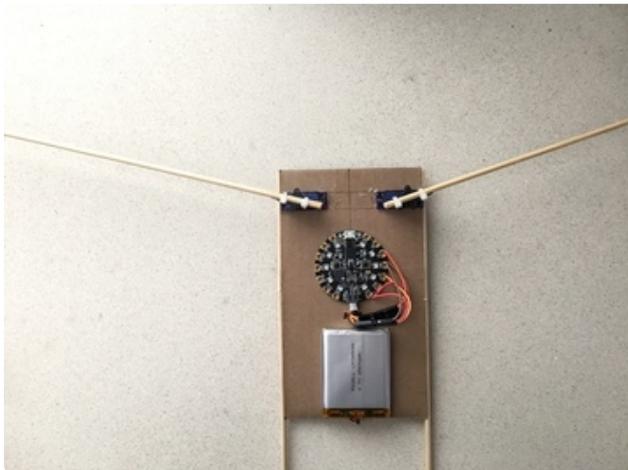
Testing the Arms



Add these blocks to your MakeCode program so the arms can be tested using the two Circuit Playground Express buttons.



When extended the bot should look like the photo to the left.

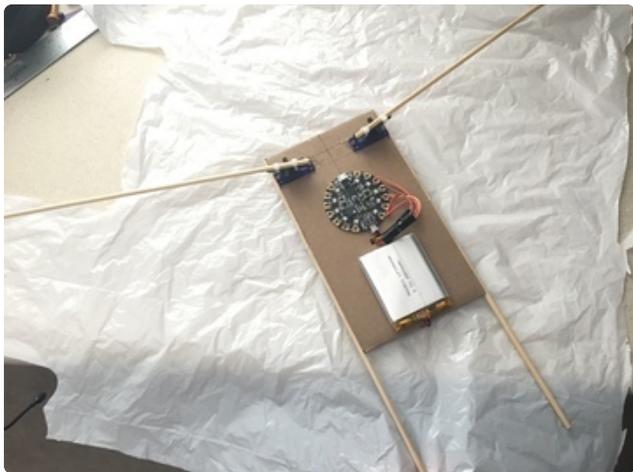


Be careful not to interfere with the servos. Doing so can risk stripping their gears.



Adding Wings

Place the bot with it's wings extended on a sheet of plastic. This could be a shopping bag or garbage bag that's been cut to provide a single sheet.



Use hot glue along the skewers on the sides of the bot and attach the plastic sheet. When that's dry use hot glue at the ends of the wings to attach the sheet. Do not stretch it tight, it has to be loose enough to allow the arms to extend as well as retract fully. Failure to allow that will result in stripped servos. Again... this was proved by trial and error. Metal gear servos might be a better choice. Although they would add more weight.



Be careful as the tip of the hot glue gun will instantly melt the thin plastic sheeting.

Finally, trim the wings to a roughly triangular shape.

Code

We already have most of the code in place due to the testing we did earlier using the buttons. All that's left is to automate operation of the wings. We can use the accelerometer on the Circuit Playground Express to trigger their extension and retraction.

When freefall is detected, the wings should open. When it lands (which we can sense by the impact), they should close. The MakeCode accelerometer support blocks provide precisely what's needed. The code is shown below. Since extending and retracting the wings is done in multiple places, the servo operations have been moved into functions that are then used as required. You can select `function` blocks under **ADVANCED** then the **FUNCTIONS** block group.

Open the code in MakeCode

<https://adafru.it/B-n>

Wrapup

Use

Best results were achieved by holding it level and launching using a gentle underhand motion. Once in freefall the wings extend and it will glide (although that might be overly generous) down, landing with a bump that will trigger wing retraction.

The wings as described slow the fall of the device and, in conjunction with the battery counterweight, keep it level and land it in a relatively controlled manner. That said, throwing it from any significant height is not suggested. Initial tests were conducted over a bed, although later flights (shown in the GIF on the first page of this guide) were successfully conducted onto laminate flooring from approximately four feet. Also, testing it outdoors is probably not the best idea as wind gusts could prove disastrous.

Going Further

This project is a demonstration of what can be done quite simply with just a Circuit Playground Express and a few other pieces. The result is fairly delicate. A more elaborate (and stronger) arm mechanism could be designed, and stronger servos could be used, both in terms of torque to handle a more complex arm, as well as

using one with metal gears to better mitigate stripping. Some sort of feedback could be used to stop the servos before there was a problem. All that aside it's a fun demonstration of what's possible.