

# HOW TO MAKE A MOSQUITO GLIDER FROM A THIN SHEET OF TIMEWARP FOAM

Much more information about Walkalong Gliders/Air-Surfing and links at <http://www.sciencetoymaker.org/airsurf/index.htm>



## Video Instructions to Make the Mosquito Glider

It might be easier for you to see the steps on video

<http://www.youtube.com/watch?v=fA7hYe1ft1E>

or if YouTube is blocked in your school, try

<http://sciencetoymaker.org/airsurf/videos/mosquito-make.mpg>

## PDF Pattern for the Mosquito Glider

<http://www.sciencetoymaker.org/airsurf/images/GLIDERS/MosquitoPattern.pdf>

When you print, see #2 below to make sure it prints at the correct size.

## 1. Getting the Right Foam

Mosquito Gliders are made from sheets of extremely low-density recycled Timewarp foam, sliced to a thickness of .5 mm. It is not unusual to accidentally rip the first piece. Handle it very gently.

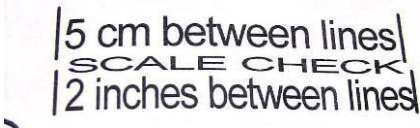
It has taken me 5 years to evolve from paper gliders (people don't believe it, but paper is heavy); to EPS (expanded polystyrene, the white foam used for packaging); and finally to TimeWarp, which is less than half the density of typical EPS foam. That makes a huge difference in flying efficiency and now people can learn to fly in minutes. Like you, I am frugal and make things, so have no problem with you collecting and slicing your own foam. But you don't have to "reinvent the wheel". Even if you plan to slice your own foam, I recommend that you buy a small batch of it first from <http://www.sciencetoymaker.org/airsurf/store.html> to see what TW foam is like, sliced to the right thickness. Furthermore, every batch of foam comes with at least one ready-to-fly (RTF) glider in the package. **Making a glider is much easier if you can fly already, and you can reference the finished glider as you build.** Then instructions make more sense.

Walkalong gliders are great to experiment with, but follow the directions exactly for the first one—get it flying-- then innovate. Building the first one is not intuitive. Although you will be able to construct gliders in a few minutes once you are familiar, the first glider you make will seem to take forever. If making a walkalong glider that you can surf on an invisible wave of air is important enough, you'll find the time and attention to invest in the first one.

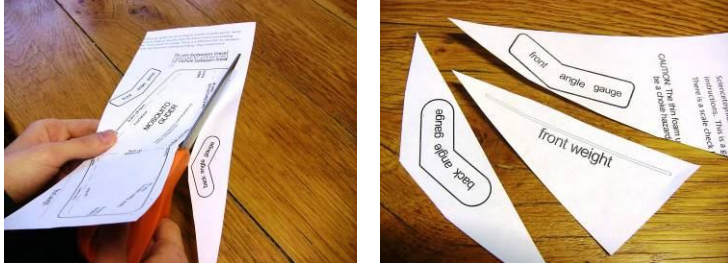


## 2. Print Out and Rough Cut Out the Mosquito Pattern

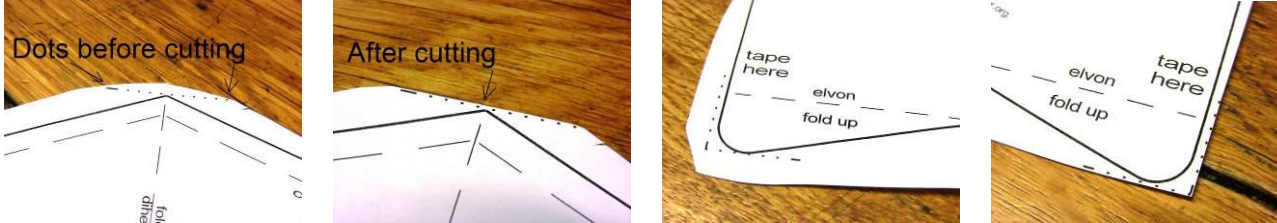
It is possible for the size of the patterns to become distorted—usually smaller. In the print dialogue box of Acrobat PDF Reader and Safari, do not allow “fit to page”. Set it to “100%” or “no scaling”. For Explorer and Mozilla go to File, Page Setup, and uncheck the “shrink to fit” or similar option. After you print out, there is a 2 inch and/or 5 centimeter scale check to make sure it’s correct.



Rough cut out the Mosquito pattern and save the front angle gauge, back angle gauge and front weight.



There are some black dots on the pattern in three places: the front point and the two back corners. Cut on these dotted lines so that the pattern will fit ok on the foam.

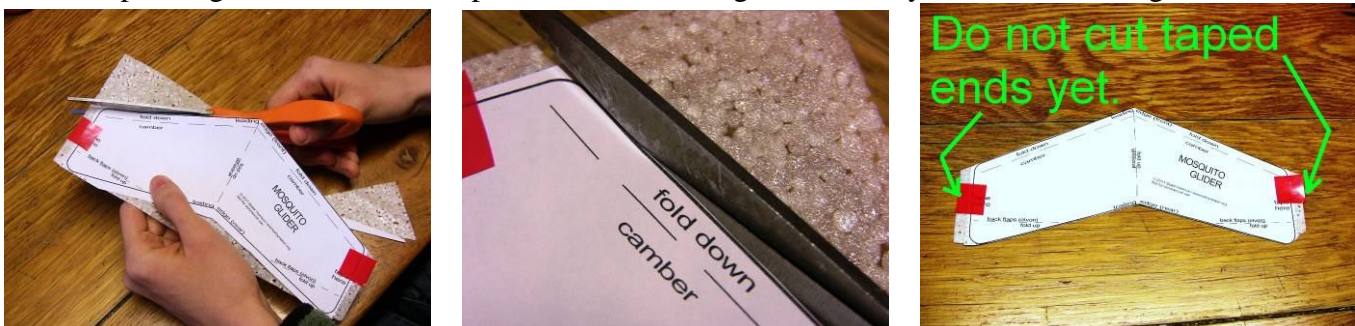


## 3. Tape the Pattern to the Foam, and Cut

Get the pattern centered on the foam as shown, so the pattern is completely on the foam, not sticking over the edge. Equal amounts of foam stick out each side, so you can tape the pattern to the foam on the ends. I am using red tape only so it shows up on camera.



Cut on the outside solid line BUT DO NOT CUT OFF THE ENDS WITH THE TAPE YET. You need to make folds before separating the foam from the pattern. When cutting, I cut exactly on the outside edge of lines.



## 4. Fold on the Dashed Lines

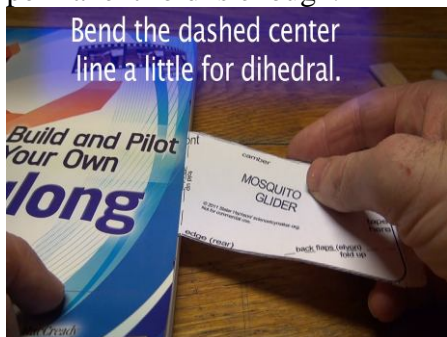
You are just establishing the folds in this step. Later you will set the exact angles. Use a paperback book that is at least 6mm thick to make folds.

Start with the 2 front “camber” folds. Tuck the glider under just the cover of the book so that one of the dashed “camber” lines just peeks out. The camber folds create an airfoil shape that makes for a more efficient, easier to control glider than one with a flat wing.

Fold **down** using your finger to push firmly against the edge of the book. With your other hand, hold the book cover down, close to the fold. The paper pattern protects the foam as you fold. When you take it out and flip it over, you should see a clear, straight fold line. Put it in again and fold the other dashed front camber line.



Put the foam/pattern in again so the dashed **center** line peaks out from the cover, but this time fold **UP**. It's a good idea to use a ruler or something flat so as to apply the pressure evenly. Fold just enough to create a permanent bend; you only need a little bit of bend. Be careful not to rip the foam, because here you are pushing against the foam directly, without the protection of the paper. This fold creates the “dihedral” in the wing: a slight upsweep of the wings that increases flight stability. You do not have to fold all the way over. Just enough of a bend to make a permanent fold is enough.



Finally, put the foam/paper in under the cover again with the back flaps (elevons) and their dashed lines peaking out. Again, fold **UP**: and again it's a good idea to use something flat to avoid tearing the foam (small tears usually do not hurt anything). Unlike the other folds, the elevon folds are creased more. Fold them all the way over and push down on the ruler. These folded-up elevon flaps stabilize flight by preventing diving.

Make sure you've made the folds correctly before proceeding. With the paper pattern on top, the front cambers fold down; the dihedral sweeps up; the back elevons bend up.



### 5. Separate from Pattern, Add Front Weight

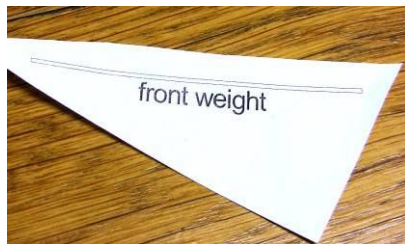
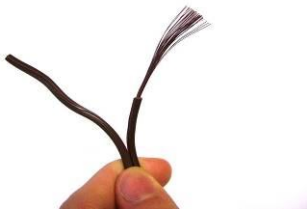
Cut off the taped ends on the solid line. You should now be able to separate the foam from the pattern. Pull apart carefully so as not to rip the foam.



The front weight keeps the glider going forward. Without it, the glider flounders. The best front weight will be long and flexible so you can adjust it easily by bending forward or backward (adjust in Step 6).

You can use lots of things for front weight. If you are using the ultra-low density foam from sciencetoymaker, then the following suggestions for paper and copper wire will get you close to the right amount of weight. You will still have to fine-tune it, below.

On the pattern page there is a pattern for a weight of paper, and paper works well. For front weight that's a little stronger—good for taking off right from the board--the sciencetoymaker ready-to-fly gliders use the very thin copper wires that are found in any wire that plugs into the wall. If you are throwing away something electrical anyhow, you can strip the insulation off and salvage the copper. I suggest about 3 or about 9 cm. to start with. You might have to add or snip off a little weight. You can also make a very thin wire out of aluminum foil.



Whatever you use for front weight, use a very small piece of tape to hold it on. I use thin, clear tape (I used red tape here just so it would show up on camera). The tape should not be bigger than a 1/2 inch by 1/2 inch square (12 or 13mm square). I know that it seems unimaginable that a piece of tape a little bigger than that would weigh too much, but it's so!

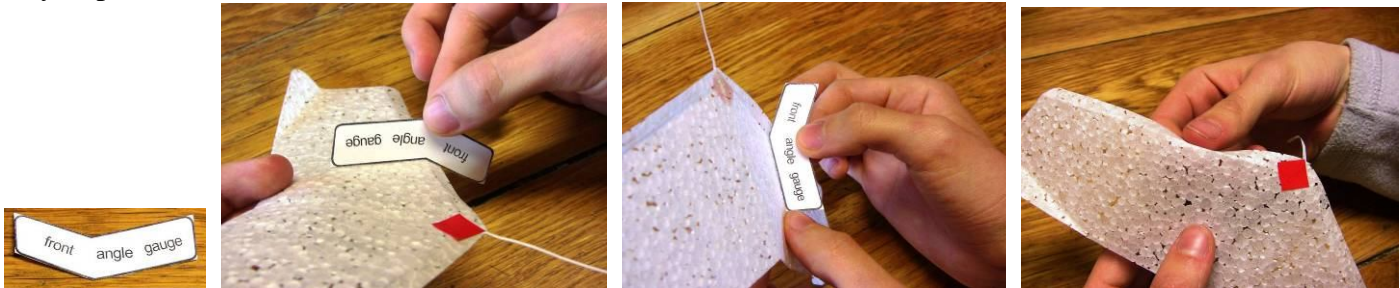
Put the diamond-shaped tape at the end of the weight (this is tricky with wire because it wants to stick to your fingers more than the wire). Tape in on so the corner of the tape is at the front, leading edge tip of the glider, on top. Bend the glider down 90 degrees as a starting position, and adjust from there.



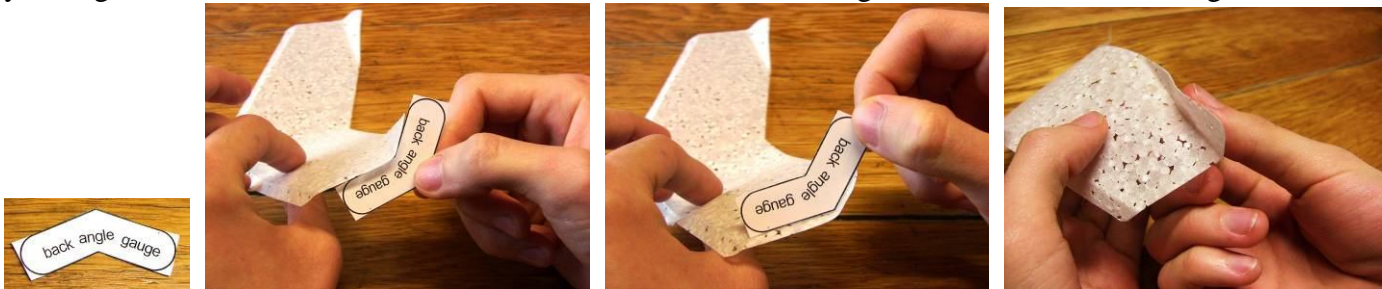
## 6. Set Angle of Front Camber and Back Flaps

I know that the first time building a glider seems to take forever and you are itching to fly. Indeed, after you have made one or two, gliders will only take a few minutes to construct and seem easy. But this first time you have to learn to adjust the glider.

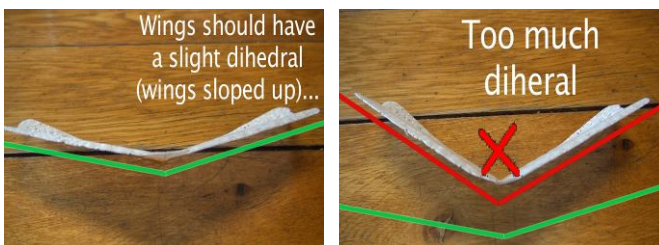
Cut out the front angle gauge. You can check the angle from the top or from the bottom. Carefully bend the foam make it conform to the angle of the front gauge. If you find that the foam springs back too much rather than taking the correct angle, I find that it helps to pinch the folds too much. Then I bend them back to the position and they seem to stay in position better.



Cut out the back angle gauge and use it to make sure both the back angles are bent up that much, to 45 degrees. Later, you might have to bend one or the other more, to correct for turning, but start out with a 45 degree bend.



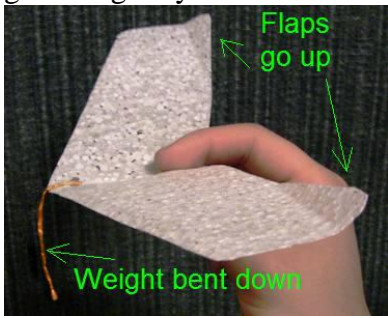
Check the center, dihedral angle. The wings should slant up just a little bit. Too much dihedral will give you poor flying results, though.



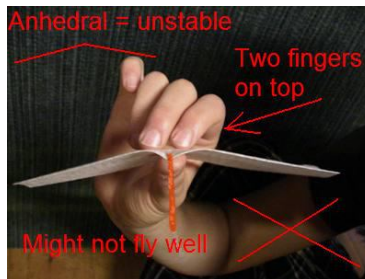
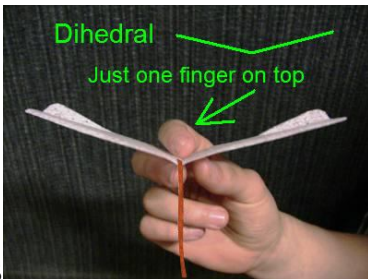
## 7. Test Glide and Adjust

You will need very calm air to fly in. Outdoor air is almost never calm enough to fly. Even inside, air conditioning is aggressive in some indoor spaces. You don't need a big room, but you need very still air.

Make sure that you are holding it right-side up with the back flaps bent up; the front wire is bent down. Hold the glider—gently—from the back. Two fingers should be on the bottom (or finger and thumb), just one finger on top.



The reason you have two on the bottom and one on top is to keep the dihedral, which is the slight upward slant of the wings (exaggerated a little). You need a little dihedral for stable flight. If 2 were on top, it could cause the wings to droop and not work.



THIS NOT THIS

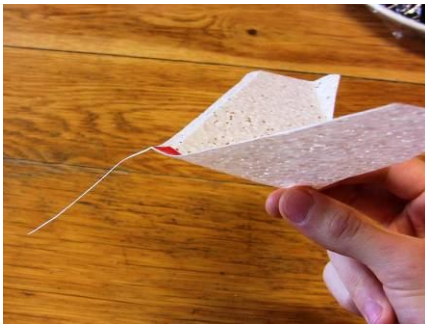
Hold the glider at least as high as your head, slant it slightly downward, give it a slow, gentle push only to flight speed and let go. Try to figure out which of these is happening: a very slow, steady glide; diving (too steep and too fast) and stalling (bobbing up and down in peaks and valleys). A little bit of stalling is actually good to learn with. Stalling and diving are opposites.



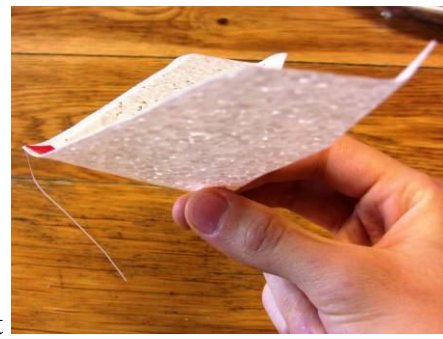
Several parts of the glider determine if it glides, stalls or dives; but if you followed instructions so far (front angle, back angle), then you can concentrate on one variable: weight. Keeping these 4 rules in mind as you adjust might be enough to get good flight (more detailed information about why it works is farther below).

- Adding more front weight (tape, glue, wire) reduces stall, but can make diving worse.
- Opposite a., cutting off weight reduces diving, but can make stalling worse.
- For fine-tuning, you might not have to actually cut or snip weight. Bending the front weight forward is the same as adding weight (reduces stalling).
- Bending the front weight toward the back of the glider is the same as cutting off weight.

I think it is best to adjust until the glider just bobs a little—not full stalling—then either fly it that way or adjust only to the point where the bobbing disappears. I think it is better to have a little bobbing than it is to have a little diving.



Like more weight

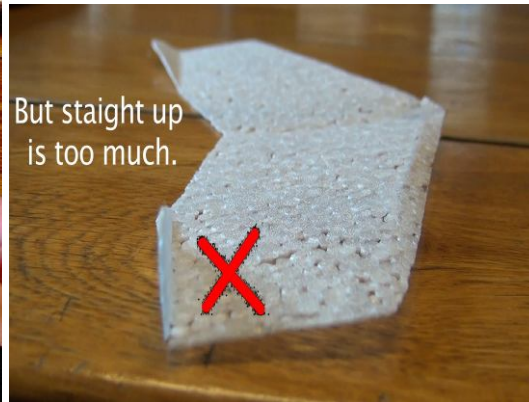


or, like less weight

### Correcting Severe Turning During Test Glide

First, make sure that the glider is actually turning even after launch. I've seen a lot of people—including myself—unconsciously launch a bit left or right; and then it flies straight. So we have to look at whether it keeps turning and turning, or did it just start out going the wrong way?

If the glider always turns and keeps turning throughout the glide, you can correct it by bending the back flap, the one which is on the opposite side of the way it is turning. Bend the flap up a little. It will provide a little more drag and pivot the glider toward straight flight. However, there is a limit to how far the flaps should be bent up. At some point there will be too much drag and the back flaps will just act like brakes, so you could bend the other side down instead. 90 degrees up is too much.



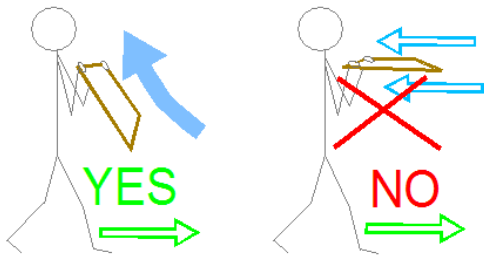
### 8. Fly Your Mosquito Glider

There is a good video about flying the glider here <https://www.youtube.com/watch?v=tac2KXEuANU> (or <http://sciencetoy maker.org/airsurf/videos/mosquito-fly.mpg> if Youtube is blocked)

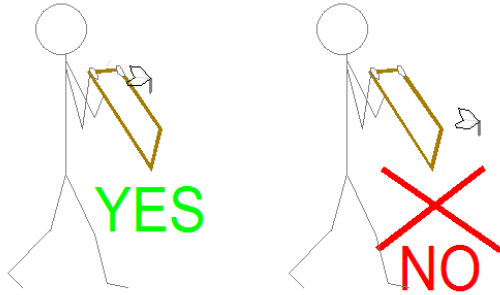
You will need something flat and somewhat rigid to deflect air up, which keeps the glider up. That deflector could be a piece of cardboard, a big book, pizza or breakfast cereal box, campaign sign, etc. Bigger surfaces like pizza boxes can be a little easier to learn with. Eventually you might learn to levitate with only your hands, arms and head deflecting the air up, but that's hotshot stuff, for later. Start with something bigger to deflect the air upward.

As we walk, the air we run into has to go somewhere. If you slant the board as you walk, the air is deflected up and over. That will create a constant, smooth wave of air to surf the glider on—no need to swish the board. In fact, if you swish the board then you will just create turbulence and flight is impossible.

It is very common for beginners to forget to keep the board slanted! Then the board just slices uselessly through the air. You can experiment with how much slant, but not flat!



It is important to keep the glider high on and close to the board. If the glider gets low and or too far ahead (most inexperienced beginners let this happen at first), then you can actually drive the glider down into a dive. You keep the glider high and close by moving faster. If Keep your movements smooth, not jerky.



Learning any new skill is awkward at first. Unless you are a hang glider pilot (they use similar updrafts to stay in the air for hours) there is nothing in life that is analogues to flying like this. It will take some experimenting and practice. The important thing is to not damage the glider.

## 9. Repair Your Glider

Small tears look terrible, but often don't make any difference in flying. If the rip is big enough that you do have to tape it, the cure can be worse than the problem (if you are not careful). The glider is so light that even just the weight of the tape throws the balance off, especially toward the back of the glider and toward the tips. In the front of the glider, tape isn't so bad because you need some kind of weight there anyhow. You can snip off a little front weight to compensate.

Because tape is relatively heavy, do not tape the whole rip. In fact, I use as small a sliver of tape as I can cut. I tape near the end of the rip, near the edge of the glider.

Rips are relatively easy to fix, but bends difficult. Lots of times kids "worry" their gliders with their hyper hands. Without even being aware of it, they squeeze and bend the glider. Or the glider gets left somewhere and things get put on top. Try to unbend. Sometimes bending the back elevons up a little more (and adding a little more weight if necessary to compensate) helps with gliders that are not quite right.



## 10. Decorate

Even if you don't rip the foam, which is very easy to do, heavy coloring can squish and warp thin foam.



Don't use those half dried-out markers that seem to be ubiquitous. And of course be ever so gentle.

I knew an artist who drew beautiful pictures entirely with dots—a good idea to apply here.



## 11. Experiment

Once you can make a glider and fly it, experiment. At first, just change one variable at a time. So, what happens if you un-bend the elevons? How much can you flatten them before something happens? What happens if you fold in more front wing camber, or less? When you have played around with what happens when you change those variables, then you gain an intuitive understanding of flight stability. You'll be able to build and adjust gliders easily, without thinking.

But we cannot have you not using your brain, so the next step is to start building your own designs. I am working on a new video about some of the basic dynamics that go into creating a design: weight, CG, airfoil, reflex, aspect ration, etc. Creating your own glider designs is quite maddening...and so rewarding! I'd like to hear about your frustrations and triumphs. You can contact me (Slater Harrison, aka sciencetoy maker) at <http://www.sciencetoy maker.org/CONTACT.html>

I will be starting a design page on the sciencetoy maker.org website to show the world the many directions that walkalong gliding/air-surfing is going.