The Flying Scrooge: Ornithopter of Household Items

by royalestei on March 23, 2007

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Intro: The Flying Scrooge: Ornithopter of Household Items

This instructable will show you how to make a nifty flying model known as an ornithopter from cheap to free stuff.

An ornithopter is a lot like a model airplane, but it **flaps its wings** like a bird or an insect, and is a lovely sight to watch in flight.

This is pretty easy to build: you really only have to make sure the bearings are all parallel. Everything else can be crooked and this will still fly just fine. It is also VERY sturdy and can take many, many crashes without breaking. As an added bonus (and due to my personal tightwaddery) it is CHEAP. You can make this ornithopter out of household items. Mine cost about $1.30 to make.

If you appreciate this instructible, please visit my blog for more ideas:

GoodCleanCrazy

Supplies:
- Bamboo Place Mat -- $1 at the local dollar store. We bought one too many for our table.
- Gel Super Glue -- $1 for a 3 pack at the dollar store. Found it in a cupboard.
- Plastic Grocery Bag -- Usually use them for tying up stinky diapers.
- Coffee Filters -- Free from work (I don’t drink coffee). And, no, I didn't steal them.
- Paper Clips
- Rubber Bands
- Bic Pen
- White School Glue
- Clear Tape -- All free stuff I found lying around

Optional:
- CA accelerator -- $4 at the local **hobby store**. Sets super glue almost instantly.

Tools:
- Sharp Blade
- Diagonal Cutters
- Scissors
- Needle-nosed pliers
- Regular Pliers
**Step 1: Assemble the Body**

I looked up “ornithopter plans” on Google and can up with these plans. However, I wanted to make an ornithopter with four wings, like this. So I decided to base my ornithopter on the free bird plans, but modified it to make it four-winged and for use with my bamboo construction materials.

Start by removing some flat bamboo strips from the place mat and laying out the body shapes. I made some triangles. Using a pencil, carefully mark lines where they overlap. Cut along the lines with your dikes. Carefully clean up the edges with a knife. Glue together with a bit of superglue and spray with accelerator.

Continue for all the joints.
1. Layout your pieces. Triangles are strong shapes.

1. Draw lines where the pieces overlap.

1. Carefully cut along the lines with your nippers.

1. Here I've just finished applying superglue to the joint.
2. Do the gluing on a paper surface. If you spill, you can scrape off the paper. Waxed paper is even better.

1. The triangle body all glued together.
**Step 2: Assemble Crank Supports**  
The top and bottom of the body need to be parallel, so add a few pieces to make the bottom rectangular.

I made some thin support pieces by cutting the bamboo in half lengthwise.

**Image Notes**  
1. Once you CAREFULLY start the cut, you can easily finish splitting the piece.

**Image Notes**  
1. I glued a thin support on both sides of the body, instead of one thicker support.

**Step 3: Add Bearings**  
Make three bearings by wrapping a large paperclip around another large paperclip. Straighten the paperclips out before you begin. Coil the wire onto a small screwdriver or a drill bit that is slightly (slightly!) larger than the diameter of the paperclip wire. This slight diameter change allows the paperclip to rotate freely inside the coil. Clip off excess wire. Based on user feedback, it seems this step is harder than it appears. When you are done making your bearings, test them for smoothness of turning.

When you have three bearings, make some bearing support pieces as pictured. Glue a bearing to the bottom of the body. This is the main crank bearing. Glue two bearings to the top, side by side in the channels created by the support pieces. These are the wing bearings.

I found it helpful to slip a couple straight pieces of paperclip inside the bearings as I was positioning them. This helped me ensure they were all parallel.
1. Wrapping the first bearing. Straighten your paperclip before coiling or you’ll get bulging "knuckles" like you see in the third wrap of this coil.

1. The finished coil. It's a bit crooked; This is also caused by not straightening the paperclips before winding.

1. This is the crank shaft bearing. Add some supports before gluing to the body.

1. One of the supports for the crank bearing.
2. The other support for the crank bearing. Glue it to the opposite side.

1. A half-thickness piece was glued flat-side out on both sides at this point.
Step 4: Reinforce Your Joints
Mix white glue half and half with water in a disposable cup. Cut out some rectangles of coffee filter tissue and glue onto the body, making sure that the tissue is thoroughly moistened with glue. Apply two layers. Let dry.
Step 5: Finish the Body

Finish the body using the photo as guidance. Add another triangle shape at the rear. The two rear spars are half-thickness to allow the tail hook to fit between. Form the tail hook from a large paperclip. Scuff the tail hook and superglue to the rear triangle. Reinforce tail hook with tissue paper.

After flying and crashing my ornithopter for several days, it broke right at the weak point between the triangles. So I added a third spar high enough to avoid the rubber band motion. I recommend you add one as well, as pictured.
Step 6: Make Wing Spars

The wing spars need to be longer than any one piece of bamboo. Join two straight bamboo pieces together by cutting as shown and gluing. The stepped cut gives more surface area for the glue to grab, strengthening the joint. Reinforce the joint with tissue. Drill a small hole through the joint.

You can make a drill by squishing the end of a paper clip and cutting it at an angle with dikes. Bend into a stepped shape and hand crank away. I made a motorized drill for this project from a VCR motor I had lying around and a thumbtack. Super glue the tack to the motor, squish the tip with pliers, and cut at an angle. Attach to 9-volt battery. I found the VCR lying beside the road a few years ago and scavenged it for parts before I threw the case away.

Form two wing cranks from paperclips as pictured. The little "jog" in the left wing crank allows good wing movement. Insert cranks into wing spars and superglue in place. Reinforce with a layer of tissue. Take two smaller pieces of bamboo and drill several holes at regular intervals. These will be the adjustable arms.

Insert the left and then right wing spar and slide the adjustable arms onto the wing and main cranks. Test wing movement. You might have to add a piece of Bic ink tube as a spacer to one of the wing cranks for easy movement.

Disassemble wings and adjustable arms.
Image Notes
1. The "jog" in the left wing crank. All the bends in this wire are right angles.

Image Notes
1. Section of Bic Pen tubing as a spacer.
2. Cranks taped in place temporarily. Super glue at this point and reinforce with tissue.
3. Left wing crank assembled.

Image Notes
1. One of the adjustable arms I made.

Image Notes
1. Testing wing movement.
Step 7: Make a Crank

Straighten a paper clip and bend a hook on one end. Insert into the bottom bearing and bend a stepped shape (the crank handle) into it.

Make a bead for the crank from a Bic Pen. Pull a Bic pen apart with pliers. Cut off a few rings of the ink tube. Fill the rings with super glue and let dry. Slide one onto the crank handle and glue in place with super glue. Be sure not to get any glue on bearing.
Step 8: Make the Tail

Save the outlines.jpg file attached to this step. Print it full size. (In Windows XP, right click on the file name and click "print". A dialog box will open. Keep clicking "Next" until it prints.) Cut out the tail section from the paper and trace onto the grocery bag. I taped my grocery bag to the back of a clipboard to have a smooth surface.

Using similar techniques as before, cut and glue two bamboo pieces together at an angle for the tail booms. I also thinned my tail booms to cut down on weight. Glue a large, straightened piece of paperclip as a tail boom. Cut a small circle out of tissue and reinforce the joint with it. Carefully cut the tail out of the grocery bag with a sharp knife. The tail should be about 6.5 inches long. Super glue the tail to the tail spars.
Step 9: Attach the Wings.

Cut out the wing outline from the paper you printed in the last step. Trace onto the grocery bag. Flip, and trace the other half of the wing. Trace a second wing the same way. Carefully cut out both wings. Cut a rectangle out at the middle of the straight edge of each wing piece. This allows the mechanics to move freely. Super glue the wings to the wing spars, starting at the center. Cut the right wing down the middle.

Insert the left wing into the left wing bearing. Insert the right wing and make sure that the wings can move freely. You might have to add a bit of ink tube as a spacer. When you have them moving well, remove the right wing. Glue the left wing to the the "spine" of the body. Add the right wing and just tape the centerline of the wing flaps to the left wing.
1. I had to blow the original plans up a bit. I saved you that step by making the outlines.jpg file in the previous step.
2. One half previously traced.

1. Cutting complete!

1. Cut out a rectangle like this from both wings.

1. After gluing the wings to the wing spars, cut the right wing down the middle like so.

1. Glue the left wing to the body.
**Step 10: Final Assembly**
Scuff up the tail boom with dikes and superglue to the body. Reinforce with filter paper. Using pliers, bend the tail boom up about ten degrees.

Hook a rubber band onto both hooks.

![Image Notes](http://www.instructables.com/id/The-Flying-Scrooge%3a-Ornithopter-of-Household-Items/)

1. Tail boom reinforced with paper.
2. Scuff marks.

**Step 11: Test Fly and Trim**
Wind up your ornithopter and test fly it. Wind it clockwise and counterclockwise to see which direction gives you smoother movement.

Here's my second test flight:

![Click to play video](http://www.instructables.com/id/The-Flying-Scrooge%3a-Ornithopter-of-Household-Items/)

If your ornithopter zooms upwards and stalls, try adjusting the tail boom down a bit. If it still stalls, you may need to tape a coin to the front of your 'thopter.

If it turns in a slow circle, you can tape a piece of wire to the wing tip on the outside of the turn. I left my wing spars long, and so I just cut off excess from the wing tips on the inside of the turn to fix that.

Experiment with different arm lengths (you know, the adjustable arm) and different rubber bands. I found that two or three narrow rubber bands gave me more consistent torque than one thick band (and also lasted longer).

Now go play with it! My daughters love watching this thing.

*Update*

I've added a couple pictures to show where to attach the rubber band (actually, I use four regular rubber bands at once) and where you wind it up.
Image Notes
1. The unwound rubber band engine.
2. This is the engine crank handle. You wind it up.
3. I put clear tape on the crank handle and both wing arms to keep everything together.

Step 12: Bearing Pictures
As per forum request, here are a few close-up pictures showing the wing and crank bearings in their final form.
Image Notes
1. Engine crank bearing.

Image Notes
1. Engine crank bearing. Here you can just see a section of pen tube I use as a spacer.
2. The rest of the bearing is under this layer of glued filter paper.

Image Notes
1. Wing arm bearings.

Image Notes
1. Wing arm bearings. You can just see a section of ink pen tubing that I use as a spacer protruding on the left.
2. The rest of the wing arm bearings are under a couple layers of glued tissue paper.

Related Instructables

- Simple guide to making paper planes by sub893
- Skull Flyer - Halloween Special from The Online Paper Airplane Museum by deannackey
- paper airplane tips by crazyace81
- How to make paper helicopters by thomas.tflux
- Simple Micro Toothpick Gliders! by crankflip
- Paper Helicopter by Itsmeallskiekfeet

Comments

- intiguy says: hey can we use a spring????????
  Mar 17, 2011, 3:50 AM REPLY

- BraisedDuck says: rather than coiling maybe you can use a balloon stick, maybe? pls reply..
  Sep 28, 2009, 7:08 AM REPLY

- goofy102938 says: great idea i've made 3 ornithopters and im sure that would work
  Aug 31, 2010, 4:06 PM REPLY

- royalestel says: What's a balloon stick? You mean, like a straw?
  Sep 30, 2009, 12:13 PM REPLY

- goofy102938 says: instead of making the complicated paper clip bearing you can make a paper tube and super glue it and it's practically like plastic
  Aug 31, 2010, 4:05 PM REPLY

- chaoshawk says: can you send me the plans at chaoshawk4@gmail.com thx (=
  Aug 4, 2010, 12:55 AM REPLY

- Patented says: Author's video have been remove, so here is another one I found made by Kipkay: http://www.youtube.com/watch?v=e3wWKEdvpY&feature=player_embedded
  Jul 12, 2010, 9:18 PM REPLY

  Skip to 2:50 for test flight !

- killer dragon says: You REALLY need measurements
  May 18, 2010, 3:25 PM REPLY

- dombeef says: He said that the plans are from the free bird plans
  Jun 16, 2010, 10:46 AM REPLY

- hyun20005 says: woo hoo!! I made it! Awesome!
  Apr 16, 2010, 5:12 AM REPLY
BraisedDuck says:
I just put too "maybes" in that sentence i'm so dumb!

Sep 28, 2009, 7:09 AM  REPLY

varrok800 says:
I made one of these, and the wings won't flap. is it because the crank isn't straight?

Sep 20, 2009, 7:19 PM  REPLY

varrok800 says:
sorry if i sound stupid, but how do you make the body? I don't understand

Sep 16, 2009, 4:21 PM  REPLY

GreenAce92 says:
Really it can be however big you want it, just study some ornithopter designs and figure out how big of a crank you need, what size wings etc... the important thing is you need to build light, and strong... because there is lots of torque/power going through the body to flap the wings... and also it has got to be very light if you want it to really fly for a good time and make sure the wings flap in unison

Jan 22, 2009, 3:30 AM  REPLY

GreenAce92 says:
i have made one of these before, except its a singlewing type, not dual. It flew only so far, they need alot of torque to flap the wings. I have a vid of mine on youtube called Jacob's Ornithopter, its made of popsicle sticks lol.

Apr 20, 2008, 3:53 PM  REPLY

pennym says:
Can anyone tell me the length of the sticks my son is trying to big one and no where is the measurements of anything can you please help

Jan 21, 2009, 7:48 PM  REPLY

royalestel says:
Dear Royalestel,

Congrats on your "ornithopter from household materials". To build one of these with such limited materials is a real accomplishment. I wanted to add a comment on your instructable, but it wasn't working, so I decided to send you a message.

Since a lot of people were looking for other plans and stuff, you might want to provide a link to http://www.ornithopter.org where there is a whole section of free plans for various designs.

(The "competition" link and also the "articles and plans" page both have several plans.)

Also, you should delete the comments from that "chirothopter" guy. Historically, the word "ornithopter" refers to any flapping-wing flying device, not just ones that have "feathers". He's only going to confuse people by trying to divide these machines into different categories. Besides, he didn't even construct the term properly: It should be "chiropter" without the "th".

Nathan Chronister
The Ornithopter Zone

PM'd to me and reposted here for everyone's benefit. The link is especially handy!

Mar 6, 2008, 10:14 PM  REPLY

budshskos says:
I have been meaning to reply to you for some time now so sorry for the late comment. I will agree with you that ornithopter is a very generalized term that is used to describe a flapping flying machine. however, if you dissect the word you will end up with orni(bird) and thopter(flapping machine) and when the word chiroptera(bat) is dissected you find chiro(hand) and ptera(wing) and when put together you end up with chirothopter and not chiropter as the word opter has no meaning without a prefix or suffix. so, if the roots are taken literally enough you end up with the three main groups of flapping machines: entomopter,chirothopter, and ornithopter and that's if you do not consider helicopters as flapping. I will also agree with you that this will confuse people and i am sorry for that. but, for those of us it does not confuse, this is very interesting peace of information and thats all im trying to make it into. i am not suggesting we change every book and website using ornithopter to the more specific term.

Mar 6, 2008, 10:14 PM  REPLY

gun says:
looks sweet!!! Dude :

Jan 31, 2008, 3:01 PM  REPLY

sb123 says:
great instructable!

Jan 21, 2008, 10:56 AM  REPLY

asdfghjkl; says:
I have a tip for other people making the coil, wrap the paper clip around a small screwdriver, this makes it soo much easier.

Dec 2, 2007, 6:46 PM  REPLY
royalestel says:
You know, I'll add that to the instructable. Another builder wound the wire around a small drill bit.
Dec 3, 2007. 12:53 PM

budsiskos says:
technically it's a chirothopter (mechanical bat) because it has no feathers and a mechanical insect would be called an entomopter (mechanical insect)
Nov 18, 2007. 12:02 PM

royalestel says:
Well, cool! Didn't know that. Have you ever made any actual ornithopters?
Nov 19, 2007. 2:35 PM

budsiskos says:
i have not made any ornithopters, though i did just recently finish a chirothopter and will begin work on an instructable within the week.
Nov 20, 2007. 9:07 PM

royalestel says:
Cool! Love to see it!
Nov 21, 2007. 4:13 AM

budsiskos says:
I just finished the instructable for my chirothopter
here's the link http://www.instructables.com/id/make-an-ornithopter-chirothopter/
Dec 1, 2007. 10:45 AM

vt93 says:
it would be better if there were measurements
Nov 14, 2007. 12:26 PM

royalestel says:
Y'know, you're absolutely right. It's on my to do list.
Nov 14, 2007. 2:39 PM

threecheersfornick says:
Hmm... looks fantastic, but I'm after a two-winged one. Any suggestions?
Oct 20, 2007. 6:07 PM

royalestel says:
Right Here.
Oct 21, 2007. 6:40 PM

Kiteman says:
Nice instructable. Making an ornithopter has been on my "to do" list for a couple of years now.
Mar 26, 2007. 5:19 PM

royalestel says:
Ah, got so much guff about the "cutting edge" phrase I dropped it.
Jul 11, 2007. 11:13 AM

royalestel says:
Oh yeah, it's the four-winged part of this that is cutting edge. I forgot about that.
Mar 27, 2007. 7:43 AM

royalestel says:
Well . . . they're on the rise again, baby! Smart-alec.
Mar 26, 2007. 7:10 PM

Kiteman says:
Yeh - here is a truly cutting-edge ornithopter: http://www.instructables.com/forum/TBRDQU7F4HZY529/
Now, who won that lasercutter...?
Jul 24, 2007. 4:16 PM

view all 96 comments