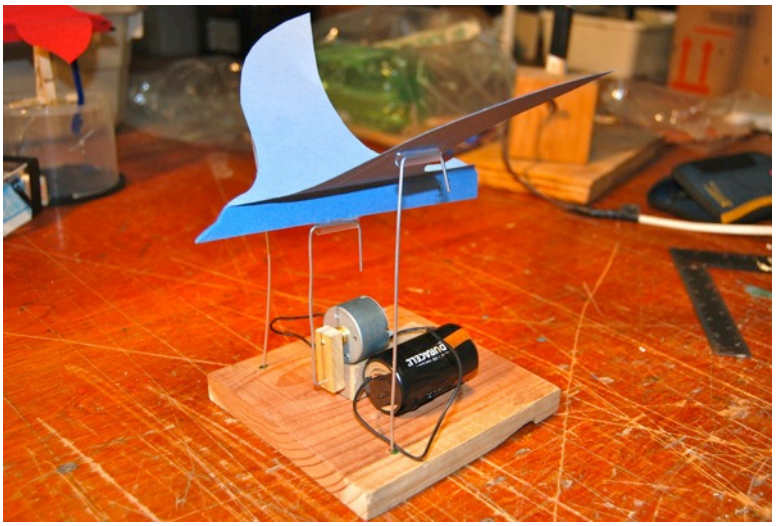
Motor Bird

Category: Physics: Force & Motion

Type: Make & Take



Rough Parts List:

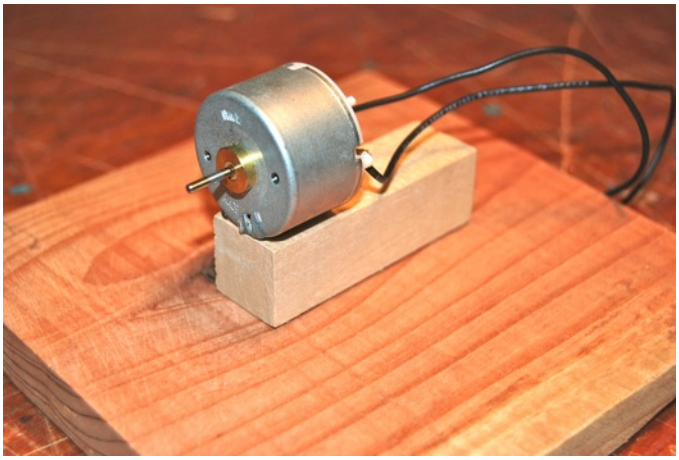
2’	Electrical wire
22”	Steel wire, around 16 gauge
1	Motor
2	Screws
1	Paperclip
1	Straw
1	Battery
1	Baseboard
2	Wood blocks, small
	Cardstock or construction paper

Tools:

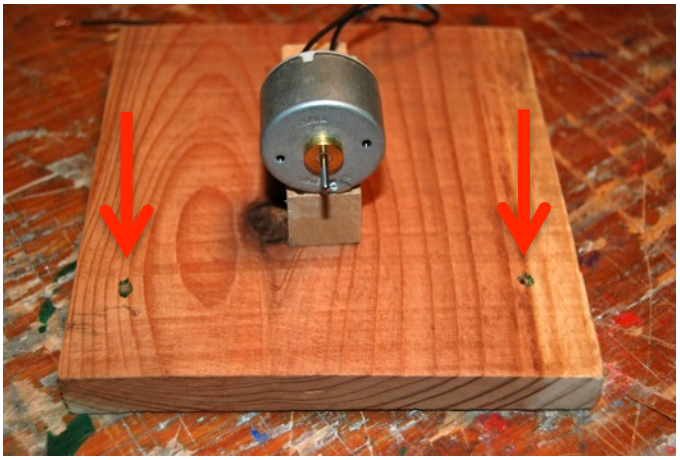
Scissors
Screwdriver
Drill with 1/16” bit and another bit same diameter as steel wire
Hot glue gun

Video: http://youtu.be/mfb0L9mzSvo

How To:



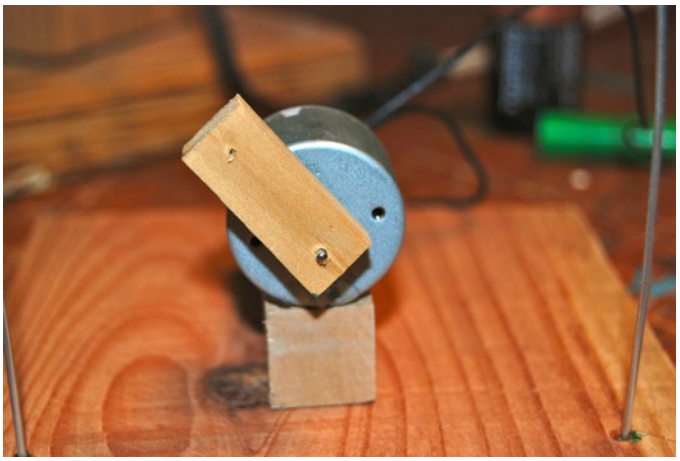
Build a base for the motor. The motor must sit at least ¾” above the baseboard.



Drill 2 holes into the base. Use a drill bit (or a nail) that is the same diameter as the steel wire.

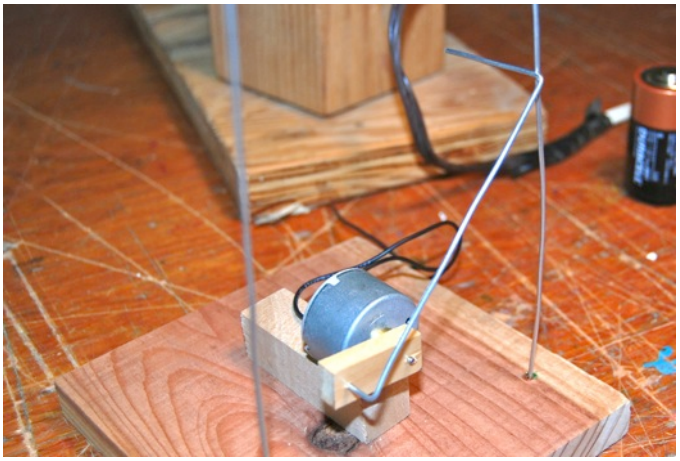
Glue an 8” piece of steel wire
into each hole.

Drill 2 – 1/16” holes into a
1” x ½” block of wood.

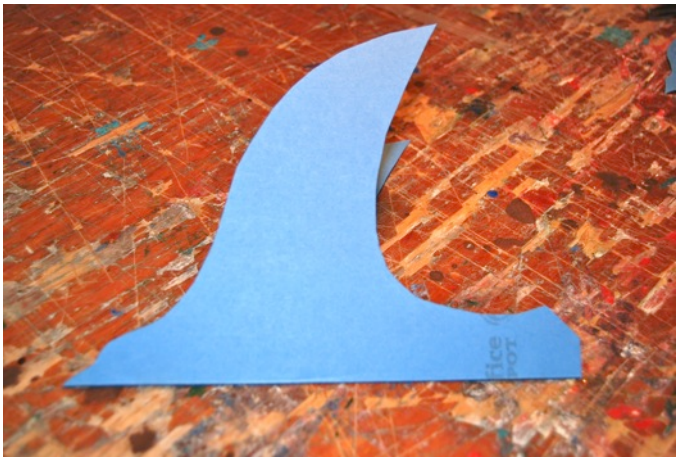


Push the motor shaft into one of the holes.

Bend a 6” piece of wire so that it has a ½” tail
on one end and a 1.5” tail on the other end.

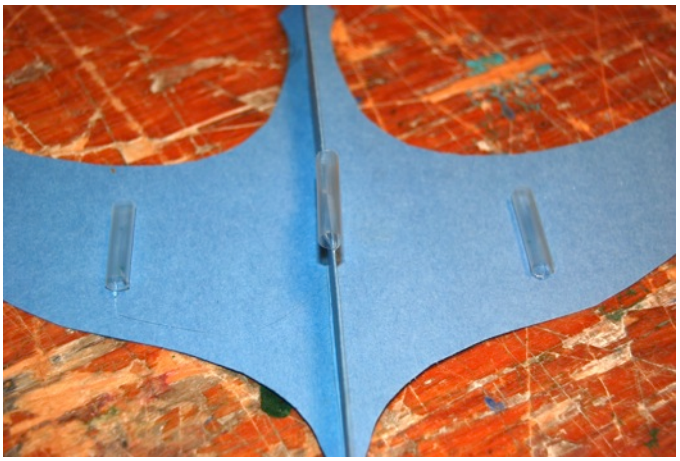


Push the smaller tail through
the second hole in the wood block.

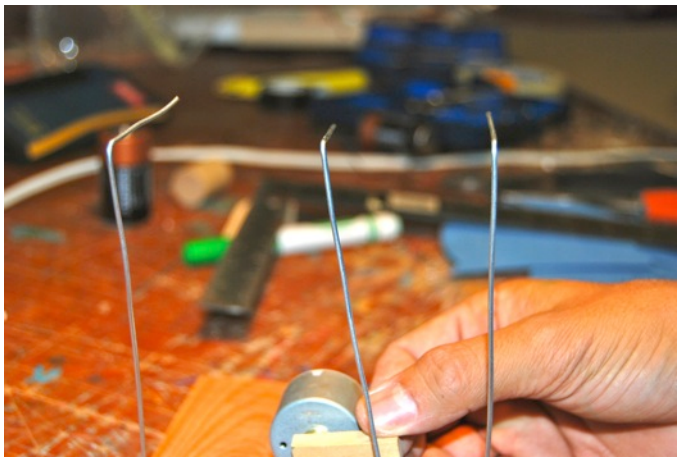


Fold construction paper in half
and cut out the shape of a bird.

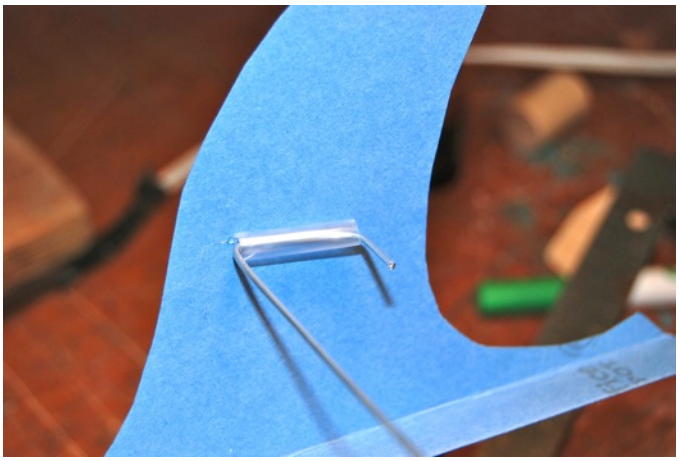
Fold a crease along the center of the bird and glue it together.



Cut 3 short pieces of straw. Glue the straws onto the bottom of the bird.



Align and bend the tops of the wires. Note the motor's wood block is horizontal for alignment.



Push one wire through each piece of straw. Carefully bend the tips down.

Connect one wire between the motor and the battery. Connect a 2nd wire to the motor. Connect a 3rd wire to the battery.

Screw 2 screws and one paperclip onto the baseboard to make the switch. Connect the loose ends of the 2nd and 3rd wires to the screws. Flip the switch and watch her fly!

Fine Points:

→ Be very careful when working with steel wire: it is very sharp!
→ All components of this project must be centered or the bird will tear.
→ Use a pencil to mark where the straws should be glued to the bird; the bird should be centered over the 3 steel wires.

Concepts Involved:

- A cam is a rotating body that conveys reciprocating (up-and-down or back-and-forth) motion to a second body.
- A crank allows you to turn a wheel or axle by providing a force at a distance from the center (torque).
- Cranks and cams can convert circular motion into an up and down motion.

Focus Questions:

1. How can you make the bird flap faster?
2. Do you think a Motor Bird with larger wings would fly faster or slower? What about one with smaller wings? Try it!
3. What other animal figures would work for this project? Name at least 3.

Elaboration:

Automata are self-operating machines that typically consist of a clockwork statue or scene and were first created centuries ago in Europe and Asia. In many ways they were the direct ancestor of what became electro-mechanical robots. Many modern toys use electric motors to achieve movement, but they still rely upon cams, gears and other principles of simple machines. For our purposes, the automaton is a good way to explore the machine's function of converting one form of motion to another. Automata are also a way to teach simple mechanical problem solving skills.

The wire crank translates rotational motion into linear motion or vice versa. The motor shaft turns, and the wood block turns with it. The wire attached to the other end goes up and down as the block goes around and around. A train engine is an example of the opposite arrangement: a shaft hooked to a peg on the wheels uses the linear motion of the pistons to rotate the train wheels.

Torque is the tendency of a force to rotate an object around an axis. Torque is the force applied multiplied by the length of the *lever arm,* which is the distance between the rotation axis and point of force application. The wire attached to the body of the bird takes torque from the motor and applies it to the bird.

A door swinging on its hinges is an example of rotational motion. Try to open a door by pushing it very close to the hinged edge. Another thing rotating on a door is the handle itself. A larger handle makes it easier to turn because the lever arm – the crank – is longer.

If you attach the straws for the two side wires to the wings close to the body, the wings should go up and down a lot farther; likewise if you attach the straws farther from the body, the wings will not move as much. Smaller wings may move faster just because they don't need as much force to move through the air. More batteries should make the wings flap faster, and a shorter crank should also make them flap faster, though they wouldn't move as much. If we didn't use a crank but instead somehow hooked the

center wire directly to the motor shaft, the automaton would only move a tiny bit. But it would probably move a lot faster: less force required for less movement.

Links to k-12 CA Content Standards:

Grades k-8 Standard Set Investigation and Experimentation

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other strands, students should develop their own questions and perform investigations.

Grades k-12 Mathematical Reasoning:

1.0 Students make decisions about how to approach problems:
1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.
1.2 Determine when and how to break a problem into simpler parts.

2.0 Students use strategies, skills, and concepts in finding solutions:
2.1 Use estimation to verify the reasonableness of calculated results.
2.2 Apply strategies and results from simpler problems to more complex problems.
2.3 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.
2.5 Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

3.0 Students move beyond a particular problem by generalizing to other situations:
3.1 Evaluate the reasonableness of the solution in the context of the original situation.
3.2 Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.
3.3 Develop generalizations of the results obtained and apply them in other circumstances.

Grade 2 Standard Set 1. Physical Sciences:

The motion of objects can be observed and measured.
1.c Students know the way to change how something is moving by giving it a push or a pull. The size of the change is related to the strength or the amount of force or the push or pull.
1.d Students know tools and machines are used to apply pushes and pulls (forces) to make things move.

Grade 3 Standard Set 1. Physical Sciences (Energy and Matter):

1.c Students know machines and living things convert stored energy to motion and heat.
1.d Students know energy can be carried from one place to another by waves, such as water waves and sound waves, by electric current, and by moving objects.

Grade 8 Standard Set 2. Forces:

2.a Students know a force has both direction and magnitude.