

real-world automatons

An **automaton** is a very special sort of machine — when you press a button or wind up a key, other parts of the automaton get pushed into motion. As all the parts whirr and spring into action, it can look like the automaton's moving by itself!

Automatons are all around us, whether they're helping us get work done, or just used for play.

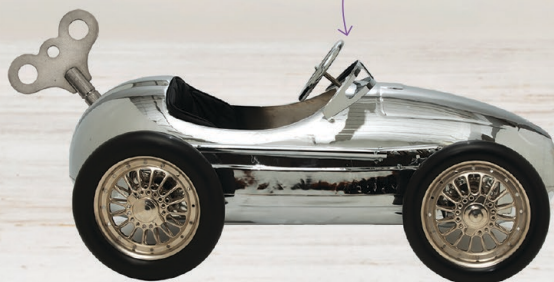
Automaton motion may seem like magic, but it's just everyday **Science**. Just think of the **vending machine**, an everyday example of an automaton. You put in some quarters and press a button, and the machine rumbles, shakes, and drops you a snack.



Ever play with a toy **jack-in-the-box**? Hiding inside that box is a machine that takes a simple motion (turning the handle) and turns it into a completely different motion (the toy's pop) — surprise!



Ever tinkered with a **wind-up toy**? You just turn a key in its back and let go, and it walks or dances or vrooms to life!



One of the most incredible automatons was built almost 250 years ago. It's a mechanical doll called The Writer, and it can actually write an entire sentence!

Automatons and their inventive designs continue to be a moving source of inspiration for tinkerers everywhere!

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THE EVOLUTION OF MUSIC BOXES

THE NEED:

A way to enjoy live music anytime, anywhere — without a live musician!

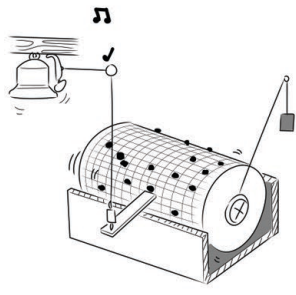
THE INVENTION:

100+ years of music box innovation.

Music boxes got their start in an unlikely place — the wonderful world of watchmaking!



It all began in 14th-century Europe, when clock towers equipped with automated carillon bells helped townspeople keep time. Inside each tower was a barrel covered in a specific pattern of protruding pegs. As the barrel rotated, the pegs set off a chain reaction that triggered a series of hammers, each of which sounded a bell that played a certain musical note. This led watchmakers to wonder — could the same technology be miniaturized to build personal music machines?



It took a few centuries, but in 1796, a watchmaker named Antoine Favre patented the world's first **cylinder music box**, swapping out the large pegged barrel for a spring-powered cylinder covered in tiny pins. As the cylinder rotated, the pins plucked the teeth of a metal comb, producing a mighty melody.

Favre's mechanism was small enough to be set inside a pocket watch!

But Favre's music box and its early successors had one major flaw — they could only play a single song. And as much as people loved having live music at their fingertips, they could only stand to listen to "Für Elise" so many times. Manufacturers soon introduced **shifting cylinders** with multiple sets of pins. When one song finished, the cylinder would shift sideways, lining up the next set of pins with the metal comb to play another song — for up to 12 songs.

In 1860, inventor Charles Paillard upped the ante further with his **interchangeable cylinder music box**,

which allowed cylinders to be swapped out, so users could enjoy a theoretically unlimited selection of tunes. But since cylinder pins were pretty fragile, switching songs was a high-risk hassle — and a good way to break your \$200 music box. *(That's about \$6000 today!)*



Cylinder music box photo by Cory Doctorow / flickr.com (CC BY-SA 2.0)

In the 1880s, inventor Paul Lochmann decided to think outside the *(cylinder music)* box. He patented the first **disc music box**, which used rotating punched-metal discs that were easier to swap out and store than cylinders. Plus, the



Disc music box photo from pixabay.com

discs could measure up to a whopping' 27 inches *(68 cm)* wide, for longer playback time. As companies around the world started mass-producing these boxes, cylinder music boxes fell out of favor.

Most music boxes today have gone back to the cylinder design. But they're much cheaper to build, so instead of swapping out cylinders for new songs, you can just buy more boxes!

Alas, the disc music box's reign was short-lived. The start of World War I meant a drop in disposable income, and many quality music boxes were disassembled for scrap metal. On top of that, most music-lovers switched their attention to the new *(and cheaper)* phonographs.

But the music box still played a key part in music history, and it's enjoyed today as a novelty item. Some would even argue that it's experiencing a comeback, as people realize that there are many ways to enjoy recorded music, but only one way to enjoy live music in a box.



THE SUPER SOAKER

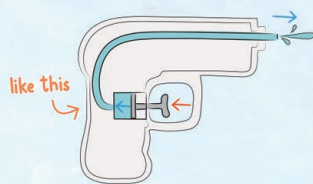
THE NEED:

A toy that could make a serious *splash* with consumers.

THE INVENTION:

The Super Soaker water gun.

The world's first water guns left a lot to be desired — like the ability to actually splash anything beyond your own arm. Many worked by pushing a small piston into a water tank to drive water out, resulting in an itty bitty *splurt*.



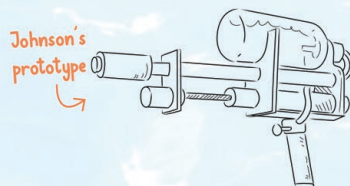
In the 1980s, everything changed... and all because a NASA engineer blew a leak.

Lonnie Johnson was trying to create a new refrigerator cooling system that used pressurized water instead of harmful chemicals. He built a pump, connected it to a faucet... and blasted water across his bathroom.

This wasn't the first time Johnson harnessed pressure power. As a kid, he built his own robot, using pressurized air to make its arms move.



In an instant, Johnson knew he had the technology for a toy sensation on his hands. He prototyped a water gun using plastic pipes, plexiglass, and a 2-liter soda bottle. Sounds crude, but it could shoot water nearly 40 feet across a room.



Unlike other water guns of the time, the pump in Johnson's toy didn't drive water out — it forced air *in*. It contained a sealed

water chamber and a slide-action pump. As you slid the pump back and forth, you pushed more and more air into the chamber, pressurizing the water. Then all it took was a single pull of the trigger to release the pressurized fluid in a high-speed, far-reaching, *wallop* of a water blast.

Johnson showed off the toy at an Air Force picnic. He blasted an officer right between the eyes, leading to an all-out water war. The other picnic-goers threw cups of water... but they were no match for Johnson.

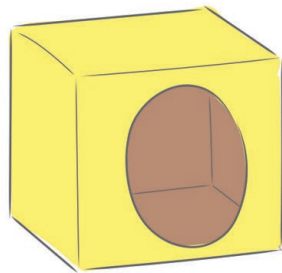
Johnson needed help mass-producing his toy, but manufacturer after manufacturer rejected him... until one little toy company took interest. During a meeting with the company's executives, Johnson took his prototype out of his suitcase and shot their coffee cups right off the conference table. The execs were *pumped*.

When the Super Soaker hit shelves in the early '90s, it blew its competition out of the water. To date, 300 million Super Soakers have been sold, totaling over \$1 billion in sales. Johnson made enough royalties off of his Super Idea to fund his own research company, and dedicated his life to invention — from new Super Soaker models, to a Nerf dart gun, to the water-based cooling system he set out to make in the first place!



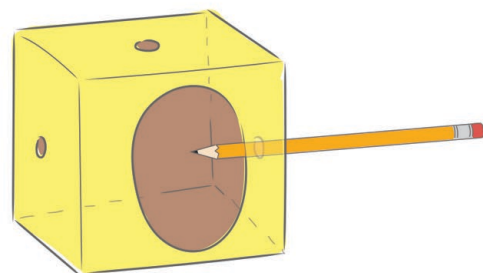
Tissue Box Automaton

Make your own simple automaton from materials you have at home!



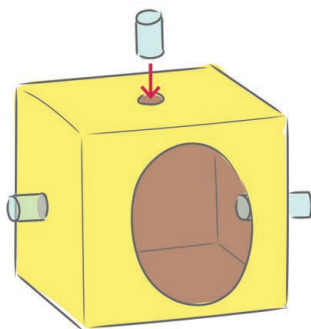
Step 1

Remove any plastic from the **tissue box** hole. Then lay the box so the hole faces you.



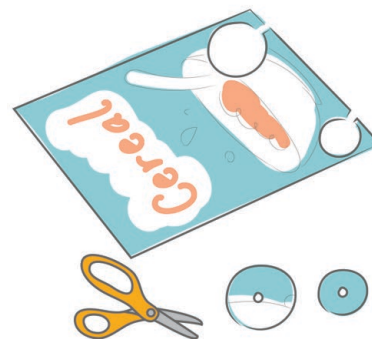
Step 2

Use a **ruler** to find the center of the top, left, and right sides. Use a sharp **pencil** to poke a small hole through the centers.



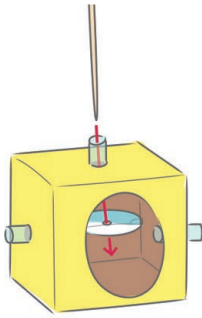
Step 3

Poke the cut **straws** into the holes. They should stick straight out. Tape or glue them in place if they slide.



Step 4

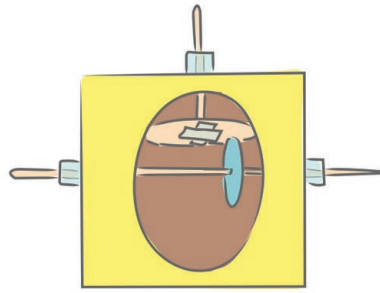
Unfold the **cereal box**. Trace and cut a large circle and a small circle (see the template page). Poke small holes in the centers.



Step 5

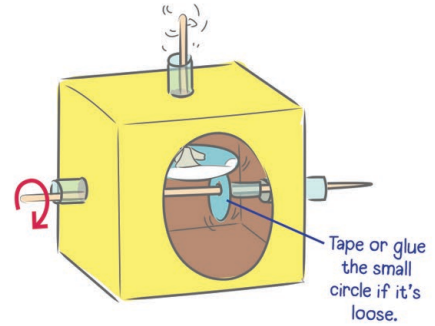
Poke a **skewer** through the top straw. Inside the tissue box, slide the large circle onto the end of the skewer. Tape or glue it on if it's loose.

tip! Flip the circle shiny-side up if you want the automaton to spin.



Step 6

Poke another skewer through one of the side straws. Slide on the small circle, then poke the skewer through the other straw.



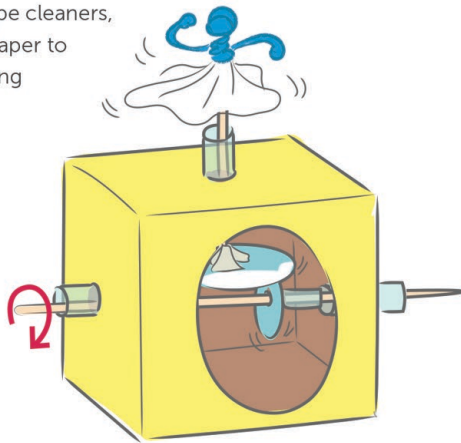
Step 7

Line up the small circle so it touches the bottom of the large circle. Then turn the sideways skewer. The vertical skewer should spin!

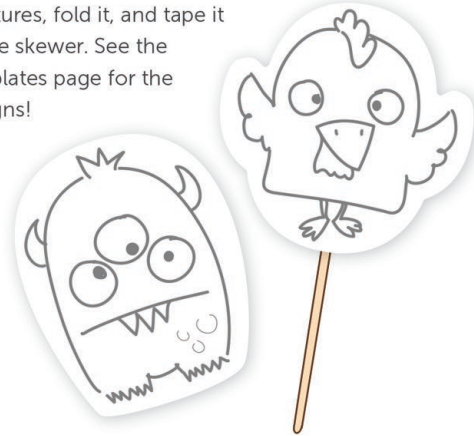
tip! Adjust the spin by sliding the small circle to a new spot under the large circle.

Bring it to life!

Add art to this basic mechanism to make a moving automaton! Try using pipe cleaners, straws, or paper to make dancing figures.

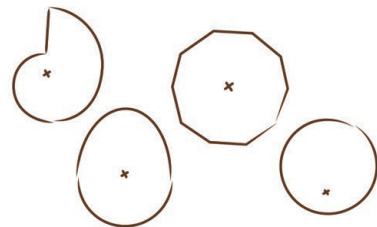


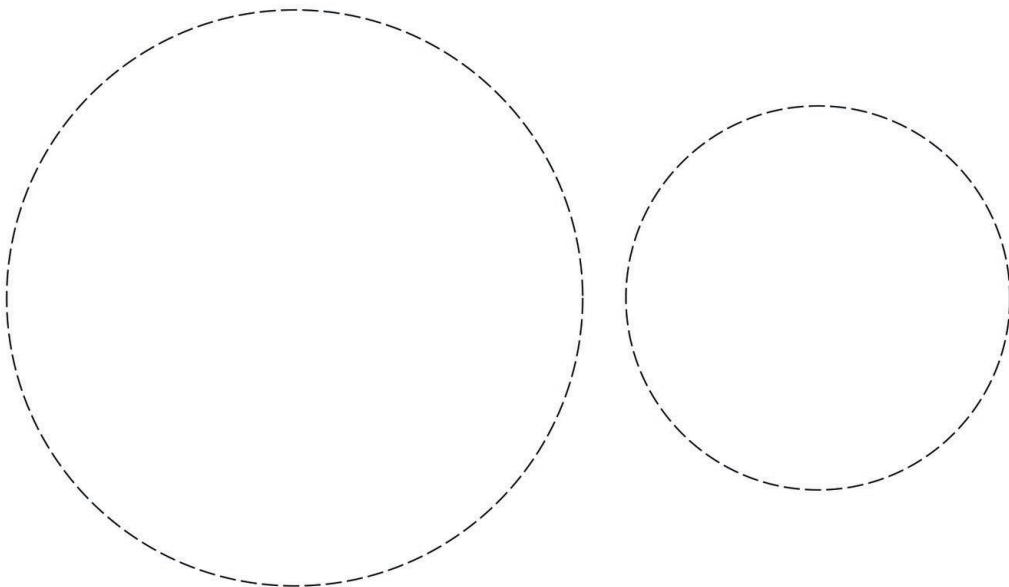
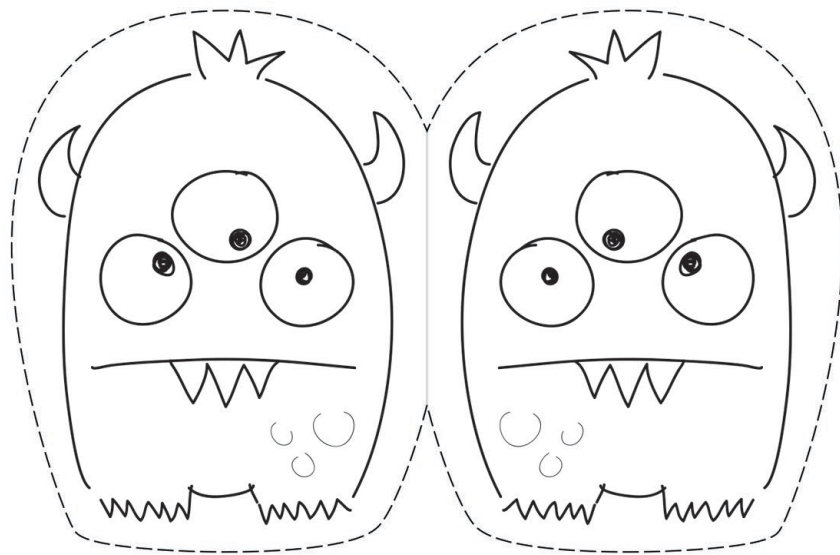
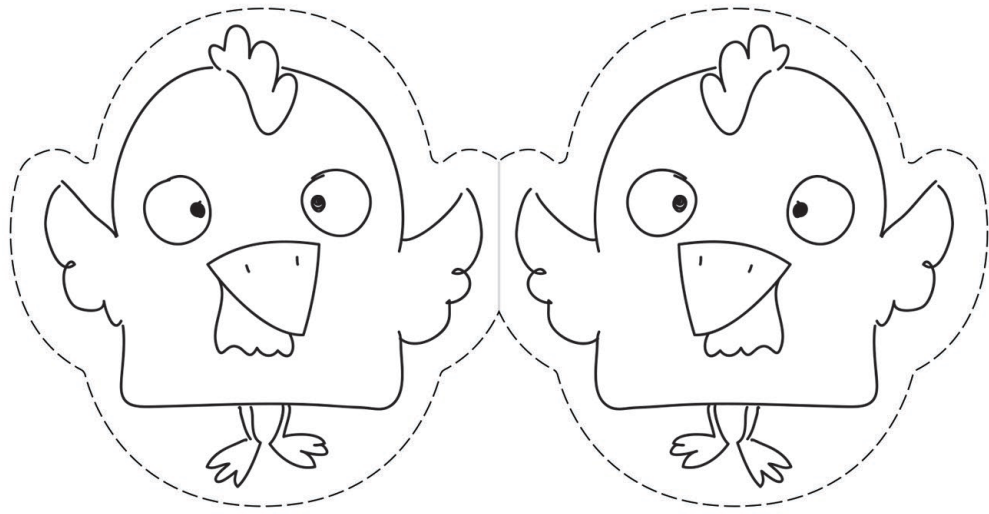
Or cut out one of these paper creatures, fold it, and tape it to the skewer. See the templates page for the designs!



Change of cams

Try replacing the small circle with a different shape of cam. What if you move the hole off-center? What if you use an oval instead of a circle? Check out our **Cardboard Cams** printable for more inspiration!





MAKE A Wind-Up Toy Painting

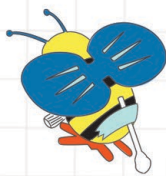
With a bit of paint and tinkering, you can turn a mechanical toy into an art-making automaton. Experiment with wind-up toys and see what kind of rolling, hopping, stomping art you can create!



What you'll need

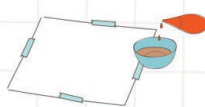
- 
wind-up toy
- 
cotton swabs
- 
tape
- 
large sheet of paper
- 
bowl
- 
liquid watercolor*

*Food coloring will work as well. Be careful, both watercolor and food coloring can stain some floors.



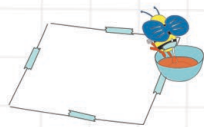
Step 1
Tape a cotton swab to the wind-up toy so the end barely touches the ground.

QUICK TIP
Break the cotton swab in half if it's too long for your toy.



This project works best on level ground.

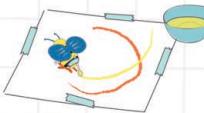
Step 2
Tape a large sheet of paper to the floor. Measure some liquid watercolor into a bowl.



Step 3
Soak the end of the cotton swab in the liquid watercolor.



Step 4
Wind up the toy and let it loose!



Step 5
Repeat with different colors of paint.



Step 6
Try different kinds of wind-up toys to create different patterns.

tinker!

If you're having trouble getting your wind-up to paint, don't despair — **tinker!** Different wind-ups may need the cotton swab taped in different places, so do some test runs to find the best position. If you're having trouble, make sure that the cotton swab isn't interfering with any of the moving parts of your wind-up toy. Then let your wind-ups run and **see what you can create!**

If you have different kinds of wind-ups, get them all together to create one giant work of art!



This activity was inspired by an exhibit, titled **Autonomous Machines**, by artist **Echo Yang**. For this exhibit, Yang created paintings with simple mechanical devices, including a wind-up toy, an alarm clock, a vacuum cleaner, and a hand mixer.



Cardboard Cams

Use this cam template to make some cams for the Tinkering with Toys STEAM Challenge.

Just print out the template, tape it to a piece of cardboard, and cut out the shapes. Use a craft knife or scissors to cut the holes in the center.

Once you've mastered making machines with these cams, try designing your own cam shapes too!

