Amazing Automaton

A cardboard creation to inspire delight!

Build time: 6-8 hours

Materials necessary: Cardboard, plastic straws, wooden skewers, hot glue and glue gun
Introduction

This cardboard automaton is a machine that uses cams to make letters or cutouts move up and down. These instructions are intended to be a starting point, rather than a guide to make only one project. If you want, you can follow the instructions exactly to make a copy of the design I made, or you can use them more as inspiration. If your automaton looks different than mine at the end, that would be an excellent innovation! This is also designed to use easily available materials, so if you think of something that I didn’t use that you think would be a great addition to your automaton, please add it!

Useful Words to Know

Automaton: a non-electronic moving machine.
Axle: a rod or shaft that runs through a wheel or set of wheels.
Cams: a rotating machine part designed to make sliding contact with another machine part.
Corrugation: the zig zag layer in cardboard.
Diameter: The length of a line from one edge of a circle to the other that passes though the center.
Flush: a construction term meaning “even with” or “in line with”
Offset: not centered, asymmetrical.
Perpendicular: at a 90 degree angle to.
2 1/4”: Two and one quarter inches.
There is a template for pieces that accompanies these instructions. You can use that if you like, but I will also include measurements for all of the parts if you choose not to use it. If you print it out on a regular sheet of printer paper, everything should be exactly the right size to trace and use.

Before you start, it is a good idea to draw a sketch of what you want your final project to look like. I would also read all of the instructions, because things will make more sense if you know how everything will eventually fit together. I knew my project needed six cams because I wanted it to say “WONDER” when I was done. I also wanted each letter to float up and down in a wavy pattern, so each letter needed its own cam. If you are using fewer cams, only make as many as you need.

I used a compass to draw 18 2” diameter circles, 3 per cam. Then I cut them out using an Exacto Knife, but scissors would work just as well. I lined them up to make sure I had enough.
I stacked each set of three, and glued them together with hot glue. It is important to try and line the edges up as neatly as possible, because that will make your cam turn more smoothly. I also tried not to glob the glue on, so each circle was as flat as possible.

Next, I cut the strips that will cover the outside of the cams to help smooth the edges. The strips are 1/2” wide, and 6 3/4” long. I made sure the long edge was perpendicular to the corrugation in the cardboard, which will make them easier to fold in the next step. I would cut these longer than you think they need to be, because you want the seam to be nice and clean.

Once I had the strips cut, I curled them up by hand so they would fit better around the cams. I found that wrapping them around a pencil seemed to work well. Notice that you can see the corrugation from the long edge, which makes for a much easier fold.
Once I had my cams and coverings ready, I carefully hot glued the strips around the outside of each cam. I attached one end first, and then glued bit by bit until the covering wrapped all the way around. I trimmed the extra and tried to make the seam where the ends meet as smooth as possible. If it is a little messy, a piece of masking tape smooths it out pretty well.
After putting the cams together, I needed to poke holes for the skewer to fit through. Because we want our automaton to have an up and down motion, our cams need to be offset from the axle. I drew a line down the middle of the cam, and measured 1/2” from the edge up the line.

I poked my holes using an awl, which is a tool especially for poking holes, but if you don’t have an awl, a drill bit, a sharp pencil, or even an Exacto knife can start the hole, and you can use the skewer itself to poke the rest of the way through. It’s important to make sure the hole isn’t too big for the skewer, because that will make it easier to attach permanently later on. It isn’t a big deal if it’s a little loose, but I would make a new cam if it can spin on its own around the skewer.
This next part is where you can really start to customize your build. I wanted my letters to move in a wavy sort of motion, so I staggered the cams along the axle to make a wavy shape. If you wanted the motion to alternate up and down, you could move every other cam so it is in the opposite position on the axle. If you want to stagger 4 cams all the way around the axle, that might lead to a different motion. Experiment with different ways to set your cams and see what you like!
Now that your cams are all ready to go, it’s time to make the structure that holds everything together. I wanted people to be able to see what was going on with the cams in my automaton, so I left two sides of my box open, but you can certainly make two more big sides to hide everything away if you want to keep it a secret. The rectangular pieces are 9” x 3 1/2”, and the square pieces are 3 1/2” on each side. I also poked holes for the axle in the exact center of each of the square pieces. This one is ok if it is a little loose, because we want the axle to be able to turn anyway.

I hot glued the square pieces on to one of the rectangle pieces, which will be the bottom and sides of the box. I tried to be very careful about making sure the edges were lined up, and that the pieces were perpendicular. I also cut some triangle pieces to brace the corners in place so they don’t warp or change shape. I used hot glue to attach these as well. I set the other rectangle piece off to the side, because we have more work to do on that.
The cam reader is the part of the automaton that will move in response to the cam, and hold the decorations like letters or cutouts. I used thinner cardboard from a cereal box for this, and kept the smoother colored side facing in to help it slide a little better. The rectangle piece is 1”x3/4”, and the trapezoid pieces are 1/2” tall, 2” on the long side, and 1” on the short side. The skewer piece is 4” long. When I hot glued these pieces together, I made sure that there was no glue on the inside of the trapezoid pieces, and that the skewer was exactly centered on the rectangle. It might be easiest to draw a center dot on each rectangle piece before gluing anything together. You will need one cam reader per cam, so I made six.
I added the axle and cams in just to make sure it fit, and gave it a spin just to see what it looked like. I made sure the cams were evenly spaced along the axle and wouldn't run into the sides, top, or bottom at all. Then, I removed the axle and cams and used the axle to mark where the holes for the cam readers should go on the top part of the box. I drew a line down the center, and placed the axle on the cardboard and traced the edges of the cams to show where they went. Using a pencil, I poked a 1/4” hole in the center of where each cam sat and hot glued in a 1” piece of plastic straw to help stabilize the cam reader. I tried to make sure the straws were flush with the bottom of the cardboard because I didn’t want it to interfere with the cam readers later.
Once all of the cam readers have been constructed, you can start putting it all together. I found it easiest to slide the skewers into the straws from the bottom and then flip the whole top of the box onto the sides where it would sit. You should make sure each cam reader sits directly on top of each cam, so it can move up and down without catching the sides or the seam of the cam. If it isn’t well lined-up, adjust the cam’s position on the axle slightly. Once everything was lined up well, I hot glued the cams to the axle on both sides to secure them in place. If the seams are catching on the cam readers, a small strip of masking tape over the seam can help stop it from snagging. When everything was in place and working well. I carefully hot glued the top of the box to the sides. I didn’t end up using corner pieces to hold it at a right angle because it seemed pretty square without them, but if your cardboard is bent or your edge isn’t straight, that might help hold things in place.
For the last touch on the mechanical parts, I made a handle out of some cardboard, a short piece of skewer and a straw. The cardboard piece that attaches to the axle is about 1 1/4” long, and 1/2” wide at its widest. The 1” skewer piece attaches to the other end of the handle, and a short piece of straw goes over that to make it easier to turn, There is a small cardboard stopper at the end, but a bead or some hot glue would work well too. I also made two small cardboard stoppers for the other end of the axle on either side of the box to keep it from shifting back and forth.

Now all of the moving parts are complete! The next step is to add the things that turn your automaton from a machine into something a little more interesting. I knew I wanted mind to say “WONDER”, so I thought it would be cool if I made the letters float up and down inside a thought bubble. I used some thick drawing paper and some cardboard to make a thought bubble, and drew and cut out some letters from cardboard. I used hot glue to attach the letters to the cam readers and thin cardboard strips to hold up the pieces of the thought bubble.
Conclusion

Hopefully by now you have a fully functioning automaton. I hope that you had fun making it, and that you made some mistakes along the way! I definitely did not get everything about this build right on the first try, and there were lots of parts that I made more than once (some even 3 or 4 times!). Messing up is a great way to make discoveries, and is the best way I have found to learn new things. I would love to see what you have created, and if you want to share it, take some photos or a video and have an adult help you share it using the hashtag #BakkenDiscovers. If you had fun building your first version, this is a great project to try different variations. Now that you know what you are doing, it will be even easier the second time around!
Box sides x2 or x4

Box ends x2

Cam covering (trim to fit)

Cam reader pieces

x1

x2

x3 per cam

- Offset cam
- Centered cam