Amazing Automaton II

A cardboard creation to inspire delight!

Build time: 6-8 hours

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

This cardboard automaton is a machine that uses wheels, axles, and levers to make objects move back and forth. 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 moves a wheel or set of wheels.
Diameter: The length of a line from one edge of a circle to the other that passes through the center.
2 1/4”: Two and one quarter inches.
Instructions

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 project to look like. I included a photo of my drawing so you can see an example of how I thought about things before I started, and how my design changed as worked on the project and figured out where the mistakes were. I would also read through all of the instructions before you start building because it is very helpful to see how all the parts fit together, and the instructions will make more sense if you understand how the finished machine works.
The first step in making the automaton is to draw and cut out the wheels. I cut all of my cardboard with an Exacto knife, but scissors work fine as well. I used a compass to draw two 3” diameter circles and used the point made by the compass to mark the center. Then I cut out the box pieces. The ends of the box are squares 3 1/2” on a side, and the three sides are 9”x3 1/2” rectangles. I took one of the rectangle pieces, and used that as the back side of my box. I drew a line exactly down the middle (1 3/4” from the bottom), and used that to center my wheels. I also marked on the line where the center of the wheels would be, 1 3/4” in from the edge on both sides. I then poked holes where the center of each wheel would be using an awl, which is a special tool for poking holes. A sharp pencil, an Exacto knife, or the pointy end of a skewer works if you don’t have an awl.
Once I had the back side of my box sketched out properly, I marked up the bottom piece so I would know where to put things later. I drew two lines all the way across the short side of the rectangle 1 3/4” in from each edge. This is where the axle braces will end up being glued later. I found it helpful to use masking tape to hold my pieces at a right angle so I could make sure things lined up properly.

Next, I cut out the axle that will link the two wheels together so they move at the same time. I used two layers, regular cardboard and cereal box cardboard. The regular cardboard is stiff so the axle won’t bend, and the printed side of the cereal box is smooth so it will slide along the wheel. I hot glued the two layers together. The axle is 6” from end to end, and the holes in the ends are 5 1/2” inches apart.
Once you have the wheels and axle ready, you can link the wheels using the axle. I used two 1” pieces of skewer as pins to hold the axle to the wheel. The skewer can be cut pretty easily with wire cutters or pliers; if you don’t have those around, a big pair of scissors works too. First, I drew a line down the middle of the wheels, and measured 1/2” up from the edge and made a mark for the hole. I poked holes in the wheels and axle for the pins to go. I made sure the holes in the wheels were just big enough to fit the skewer, because I didn’t want the skewer sliding around. I poked the holes in the axle a little bigger, because we want it to be able to slide around the pin without catching or sticking.
Once all the holes were poked, I put a little dot of hot glue into the hole, and poked the skewer in so the end of the skewer lined up with the back side of the wheel. I tried to keep the glue as neat as possible, especially on the front of the wheel, because I wanted to make sure that the axle didn’t accidentally catch on any glue. Then I cut two 2” pieces of skewer for the axles for the wheel, and poked holes for them in the center of each wheel. Make sure the skewers are a snug fit in these holes as well. I glued them in so they stuck out of the back of the wheel, and no skewer poked through the front of the wheel. Now we have a pin on the front side and an axle on the back side of each wheel.
Now we can attach the axle to the pins and make sure it can slide around when the wheels turn. I did this by pinching the axles on the back of each wheel, spinning them in my fingers and seeing what kinds of motion I could get from the wheels.

Next, we have to stabilize the axles. I cut two 4 1/2”x 1/2” rectangles, and drew a line 2” in from one of the short edges on each one. I folded the braces on that line to make a V shape, with one side of the V slightly longer than the other, I lined the braces up with the lines I had drawn on the bottom of the box earlier, and glued the short side of the V straight up and down, 1 3/4” away from the long edge. I glued the longer side of the V at an angle, and very close to the edge of the rectangle.
Once I had the braces in place, I wanted to make sure I had handles to attach to the axles on the wheels. I cut out two 1 1/2” circles, and used the same method to measure and poke holes as I did for the wheels. The holes for the skewers are about 1/8” from the edge of the circles. The skewer pieces are 1” long each. I glued the skewers into the holes near the edges, making sure they didn’t poke through the back of the circles. It’s ok if your glue is a little messy here.
This next step combines almost all of the pieces we have built already, so it’s going to be a little bit complicated. First, use the rectangle piece from the back side to mark where the holes in the axle braces will go. I stood it upright on its side and lined up both edges, and made dots with my pencil where the holes lined up with the axle braces.

Then, I poked holes through both parts of the axle braces, making them big enough so the axle could turn freely, but not so big that the axle wobbled around. I glued the back side of the box onto the base of the box, making sure to keep the edges lined up. Then, I poke the axles on the wheels into each hole in the axle braces, and through the back of the box, and glued the handle on the other side. I made sure the handle was lined up with the position of the pin on the wheel. So the pin was at the bottom of the wheel, and the handle was at the bottom of the circle when it was glued on. This isn’t super important, but it makes it easier to understand what is happening on the front side. If this step is tricky, there are two different perspectives of this on the next page. Look carefully at how things fit together, and make yours look like mine.
Once both wheels have been attached to the automaton, we can start to put together the rest of the pieces. Next, we need to link the wheels together with the axle that we have already made. You can just slide it onto the pegs on the wheels, but make sure both wheels are in the same position when you do this. I also added the square ends of the box to help support the back wall and keep it perpendicular to the base.

Next, I tested it out to make sure that it moved. I turned just one handle at first and saw what that motion looked like, then I tried turning both at the same time to see what that motion looked like. Experiment a little and see what you like best for the design you are making. If things are catching or rubbing when you do this, now is a good time to make adjustments so that it runs smoothly. You might need to unglue and reposition the axle braces, or just bend your wheel a little bit so it spins straighter on the axle. Do your troubleshooting now, because it gets much harder when the box has a lid.
Now we have to make the levers that will move back and forth. I wasn’t sure how long I wanted mine to be, so I used a whole skewer for each one and ended up cutting them later. It’s always better to make something too long because it’s much easier to cut it down than to add back on. The cardboard holders are 1” tall, and a bit less than 1/2” wide. The hole is 1/4” up from the bottom. The hole can be a bit big, because these parts also need to spin around the pin. It also might be useful to cut out a few stoppers, that are 1/2” in diameter with a hole in the middle, to help get spacing right between the levers and the axle that connects the wheels.

Once the levers are done, we need to make the box top. I took the last big rectangle piece and measured 1 3/4” in from each short edge, and drew a line. I also measured 1 3/4” down from the long edge and drew a line down the middle of the rectangle. I cut out two rectangles that were 1/8”x3/8” centered on the lines that I drew. This will let the levers move back and forth while still holding them in place. I slid the levers on the pins, and taped the box top on with masking tape to test that it worked.
These are some pictures of the automaton with all of the parts put together. Once I made sure everything was working properly, I glued the top on first, making sure to keep things as lined up as possible. I glued 1/2” diameter stoppers on the ends of the pins to keep the levers and the axle from falling, off, making sure not to get glue on the inside of the pin because it’s important for the levers and axle to move smoothly. On the next page, there are more pictures of the complete automaton so you can look and see how things fit together.
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!