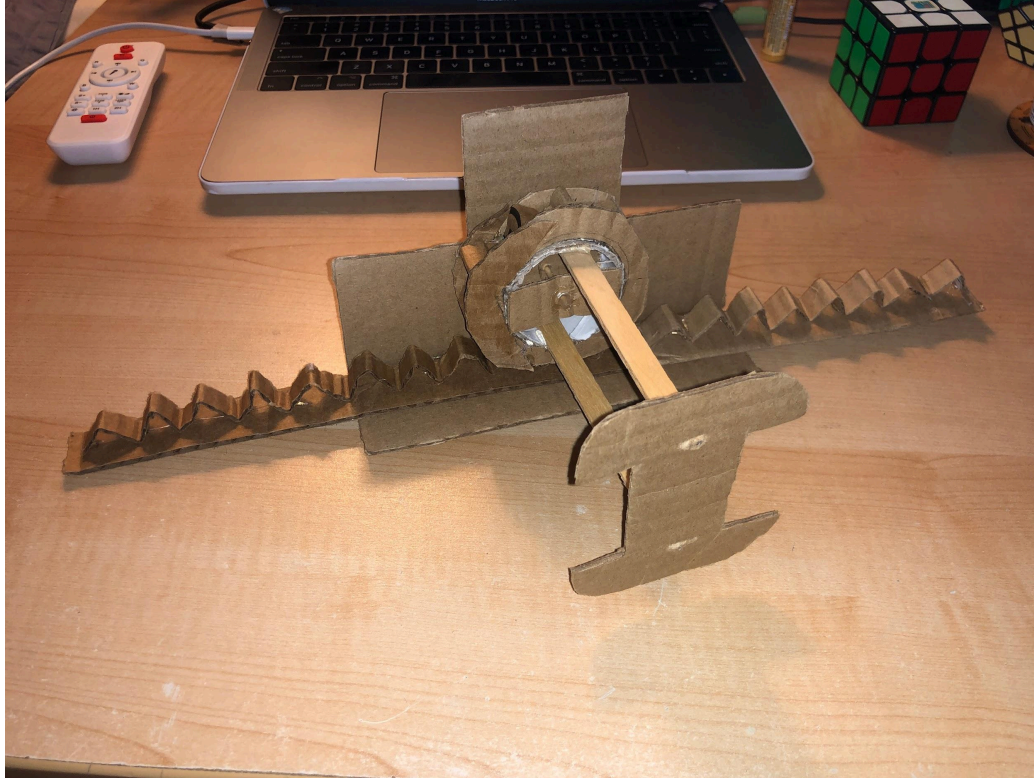


## Rack and Pinion (Steering Wheel Mechanism)



Click [here](#) for a video of it moving.

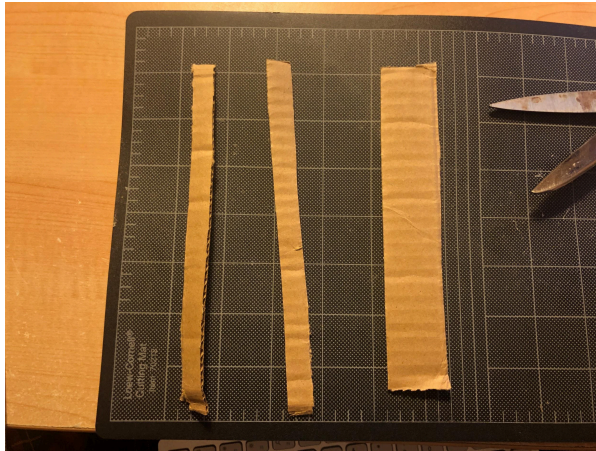
### Materials:

- Cardboard
- 2 popsicle sticks
- Toilet paper tube
- Toothpick

### Tools

- Hot glue
- Scissors
- Screwdriver

## Instructions



1. Cut two strips of cardboard, each with a width of 0.5in.

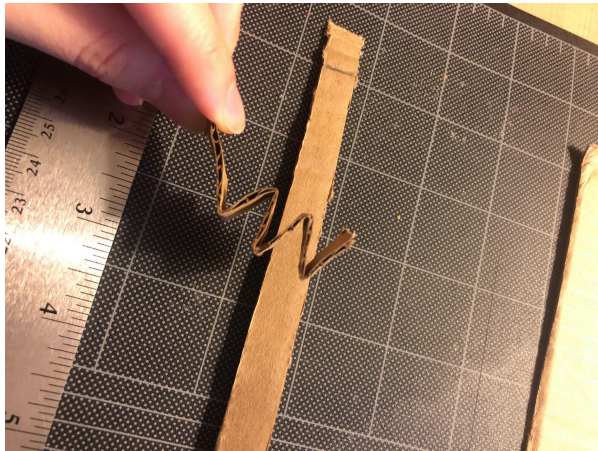
Cut another piece of cardboard, with a width of 1in.

The length of each piece depends on how long you would like your rack to be. I used a length of about 36cm for the wider piece, and 60cm for the shorter pieces

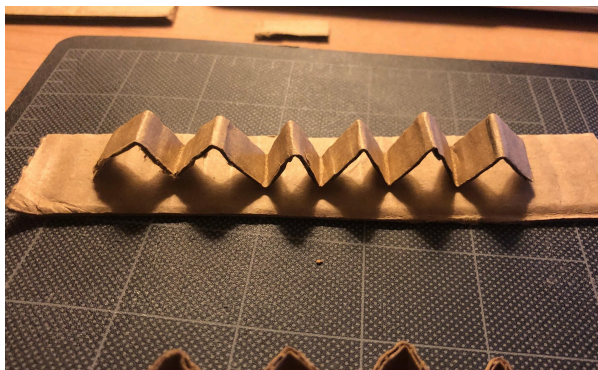
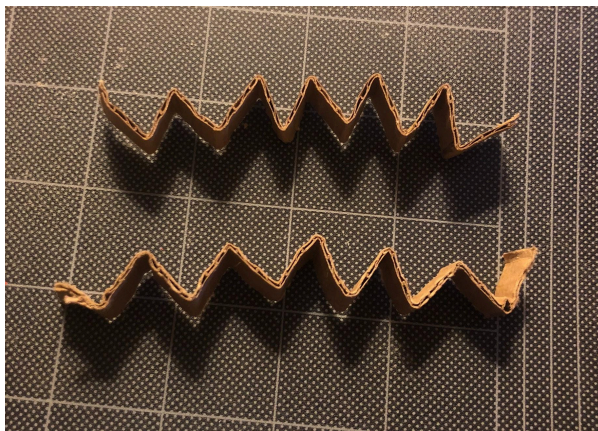


2. On each of the narrower cardboard strips, mark 0.5in from the end.





3. Fold on the marked spot. Then, continue to fold the strips every 0.5in. You should end up with 2 zigzagged strips of cardboard. These will be the gear teeth on the pinion and rack.



4. Take one of the strips and glue it to the 1in width piece of cardboard, with the arches each 0.5in apart.

This piece is the **rack**.



5. Take the other strip and glue it around the end of the toilet paper roll, with each arch 0.5in apart.

This piece is the **pinion**.



6. Get another piece of cardboard. Use a pencil to trace a circle around the pinion. The circle should touch the edges of the pinion.



Cut it out, then glue it to the end of the pinion.





7. Cut another circle piece. Trace the circumference of the toilet paper tube in the center of this piece, and cut out the circle.



Glue this piece to the other side of the ridges on the pinion.



8. Use scissors to cut the toilet paper roll that extends past the pinion pieces at the end.

Glue a piece of cardboard (1.5inx0.5in) across the center of the toilet paper roll, and punch a hole in the center. Punch another hole in the center of the cardboard piece at the other end of the pinion. Put a toothpick through these holes and glue.

Then, glue two popsicle sticks to the inside of the toilet paper roll.





9. Cut out a piece of cardboard in the shape of a steering wheel. It can be any shape of your choice, but should be at least 3in wide.

Use your fingernail to indent the cardboard about 2in apart.



Glue the ends of the popsicle sticks to the indentations.



10. Cut out a piece of cardboard (2inx6in). Punch a hole in the center, 0.5in from the top. This will be the **base plate**.



11. Punch a hole in the circle (cut from the second cardboard arch).



Put the pinion toothpick through the hole in the new piece of cardboard. Glue the circle to the other side.

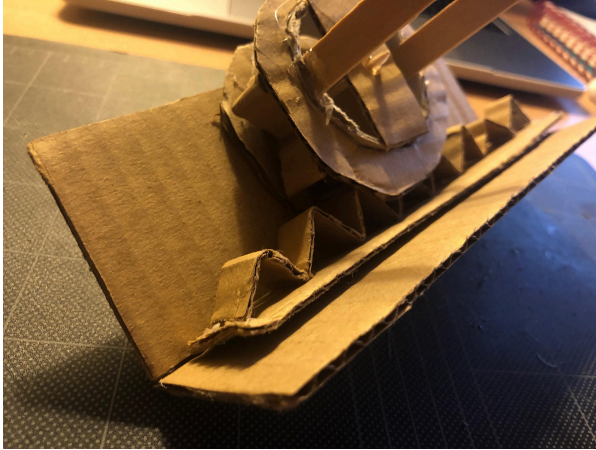




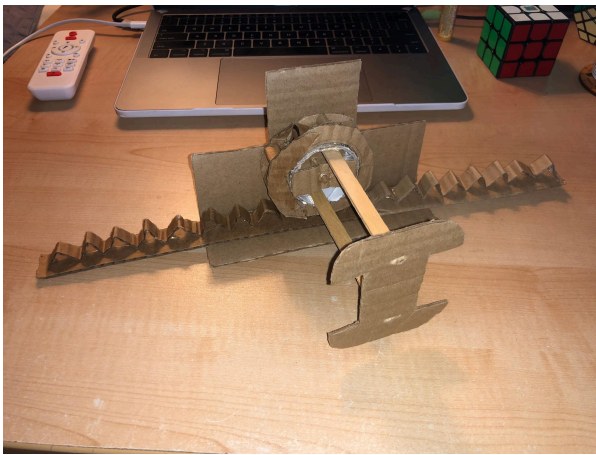
12. Cut out another piece of cardboard (2inx6in).



Glue the long edge of this piece to the long edge of the base plate (the edge opposite of the pinion)



13. Place the rack between the cardboard wall and the pinion.



14. And that's it!

When the steering wheel is turned, the rack should move back and forth.

## CAR STEERING



Application:

This mechanism is used to steer cars. When the rack moves back and forth, a hinge at each end pushes a steering arm attached to the inner side of each tire. Depending on which direction the rack moves, the tires will be pushed in a certain direction.





15. To make different-sized pinions, look around for circle-shaped objects of various sizes (bottlecaps, cups, etc). Trace these objects onto cardboard and cut them out.



Top: larger pinion

Bottom: smaller pinion



16. Use the same technique from steps #3-5 to create the teeth for the pinions. Glue them on.

Use a screwdriver to punch a hole in the center of each pinion.



Top: larger pinion

Bottom: smaller pinion

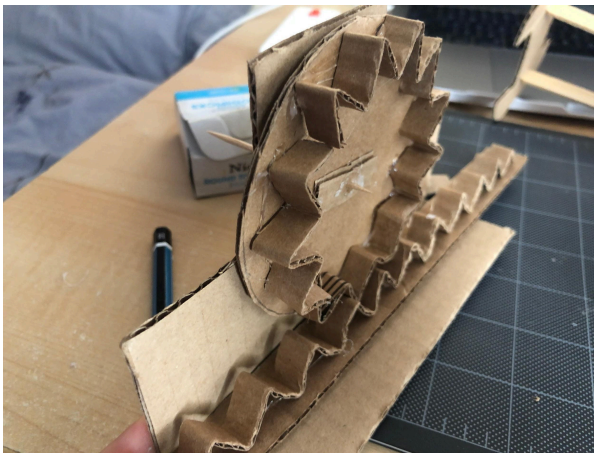


17. On the base plate, punch holes that align with the height of the center of each pinion.

Top: larger pinion

Bottom: smaller pinion

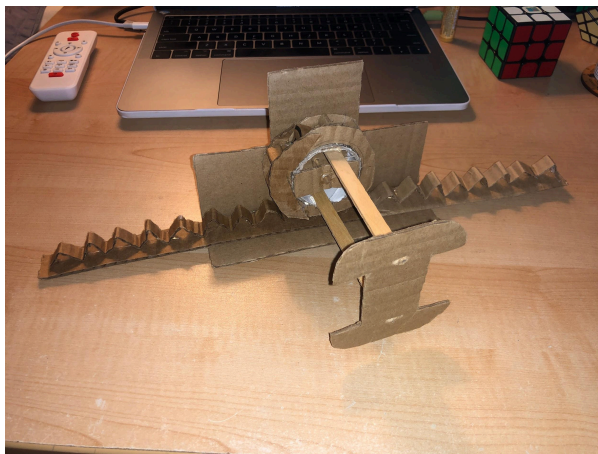




18. Attach pinion to the base plate using a toothpick (same as step 11).

Top: larger pinion

Bottom: smaller pinion



19. And that's it! Feel free to add a steering wheel (step 9). Try experimenting with more pinion sizes and rack lengths. Have fun!