# RUBIK'S CUBE MANUAL

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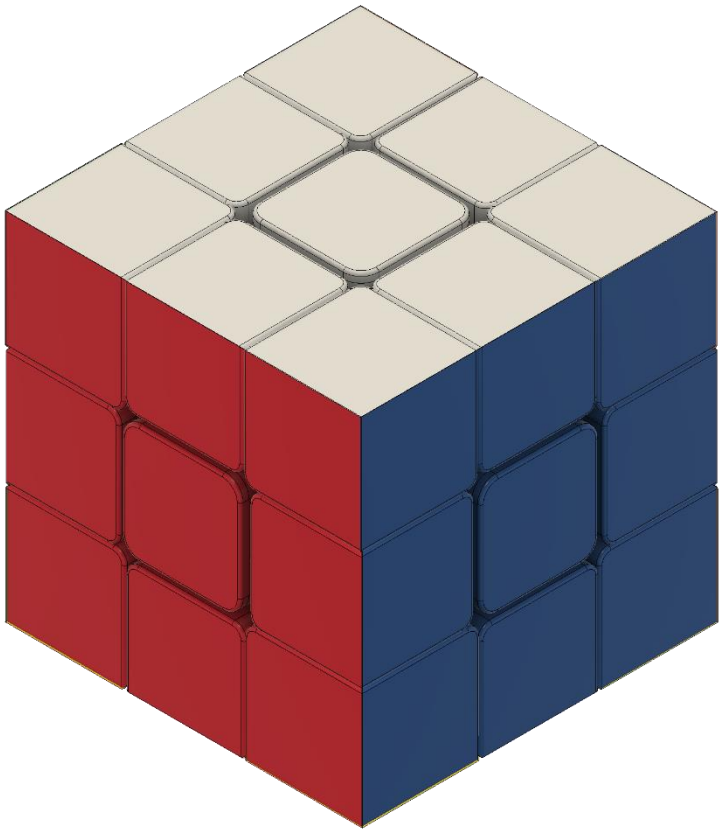
December 12, 2023



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*Note that the cube I have reverse engineered is described as "sticker less". This cube has a different manufacturing process compared to the original, more commonly recognized, stickered Rubik's Cube.

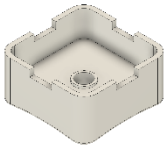
## Description

In 1974, Hungarian architecture professor, Ernõ Rubik, invented the Magic Cube, first using the cube as a ‘learning exercise to teach his students about 3-dimensional spaces.’ He only then realized he had created a puzzle when he scrambled his cube and attempted to restore it. Since then, the Rubik’s Cube has become a prominent toy, selling millions, and becoming a race for people around the world.

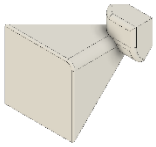
## Parts

Central Core

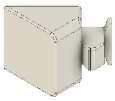
Center Pieces



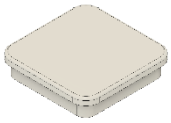
Corner Third



Edge Half



Center Cap

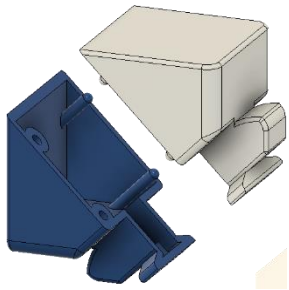
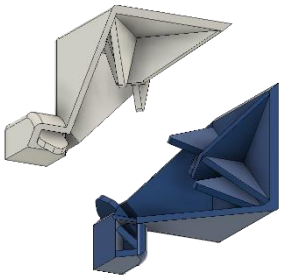
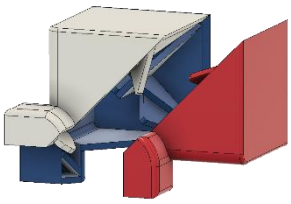
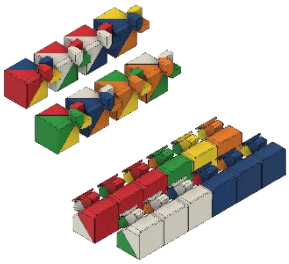
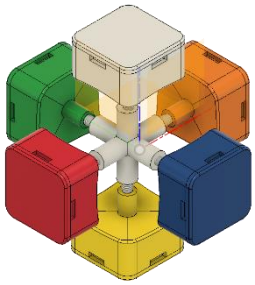
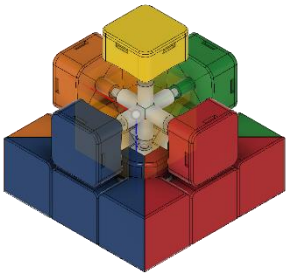
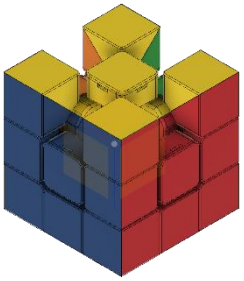
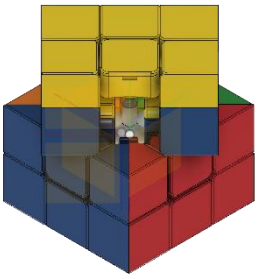


Screws

Springs

# Build Guide

Step-By-Step

| | | |
|---|---|---|
| 1.  | 2.  | 3.  |
| Assemble your edge pieces by taking two halves, matching the pin and its hole, and inserting them with the edges matching and sitting flush. | Assemble your corner pieces by taking two thirds and angling the outer edges so they match, each of the fins going to the slit. | Now, finish your piece by adding your last third, placing it through the slit at an angle and making sure that all of the stems are aligned. |
| 4.  | 5.  | 6.  |
| Repeat steps 1, 2, and 3 until left with 12 edge pieces and 8 corner pieces. | You will now need your core, center pieces, screws, and springs. Screw in the center pieces noting the order in the picture placed above. | Repeat step 5, ensuring that only five center pieces are correctly assembled, with the screws being hand tight. |
| 7.  | 8.  | 9.  |
| Taking 4 edge piece, arrange them in a cross and taking 4 corner pieces and laying it with the stem facing up. | Now, add edge pieces for the second layer between center pieces and placing the corner pieces for the last layer. | To finish, place 3 edge pieces then, twisting the cube layer 45 degrees and compressing the springs, placing the final edge piece . |

# How to use

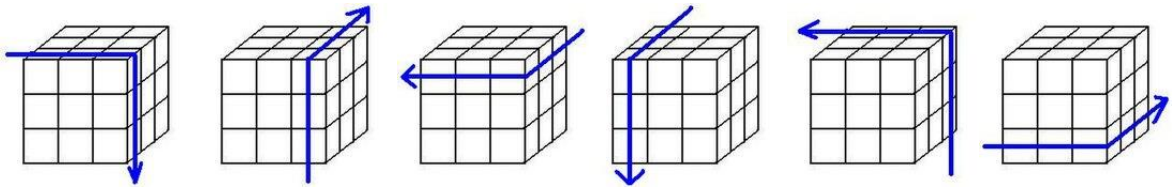
## Operating a Rubiks Cube

Using a Rubik's Cube is easy. First place a finger around a single layer, parallel to its edges, and flick your finger towards you, clockwise, a quarter turn. Many people start with the blue side facing them and white or yellow on top. Although, the color of your side chosen does not matter and is of personal preference.

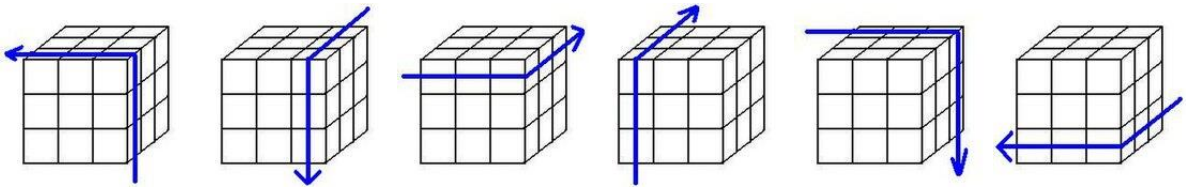
## Rubik's Cube Notation

The basics of Rubik's cube notation is first by using the letters F, R, U, L, B, and D. With this knowledge, you can perform algorithms that will help solve the cube.

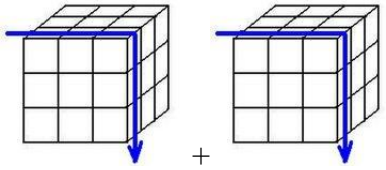
A single letter by itself refers to a quarter turn in the clockwise direction, rotating 90 degrees.



Letters followed by an apostrophe refer to turning the face a quarter turn in the counterclockwise direction, rotating 90 degrees (F', R', U', L', B', and D').



Letters followed by the number 2 refers to a half turn, rotating 180 degrees (F2, R2, U2, L2, B2, and D2).

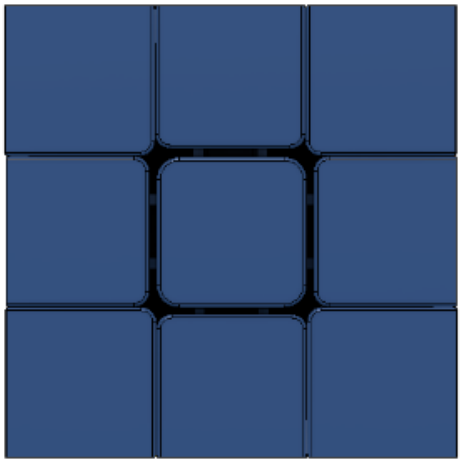


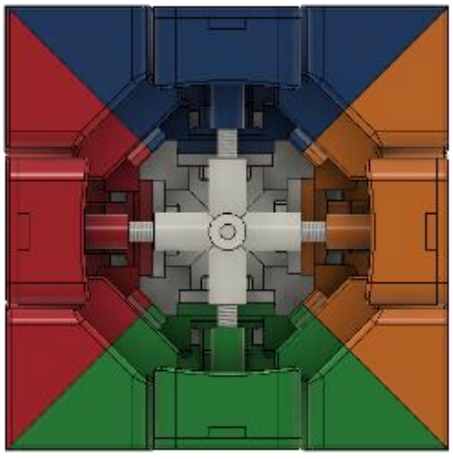
## Bill of Materials

| # | Name | QTY | DIM (mm) | Function | Material | Mass (g) | Texture & Finish | Piece Interaction |
|---|---|---|---|---|---|---|---|---|
| 1 | Central Core | 1 | 20x20 | Keeps the center pieces together | ABS Plastic | 1.7 | Rough & Satin | Screws |
| 2 | Center Pieces | 6 | 15x15 | Keeps the edge and corner pieces together | ABS Plastic | 1 | Smooth & Satin | Screws, Springs, & Plastic Screw Covers |
| 3 | Corner Third Pieces | 24 | 32x18 | Keeps the corner and pieces together | ABS Plastic | 1.3 | Smooth & Glossy | Corner Thirds & Edge Halves Pieces |
| 4 | Edge Half Pieces | 24 | 19x17 | Keeps the center and corner pieces together | ABS Plastic | 1.3 | Smooth & Glossy | Edge Halves, Corner Thirds & Center Piece |
| 5 | Center cap | 6 | 19x5 | Covers the screw and spring | ABS Plastic | 0.8 | Smooth & Glossy | Center Pieces |
| 6 | Screws | 6 | 20x7 | Holds center pieces to the core | Metal | 1 | Smooth & Glossy | Core, Center Pieces, & Springs |
| 7 | Springs | 6 | 11x5 | Allows for elasticity when turning | Metal | 0.5 | Smooth & Glossy | Screws & Center Pieces |

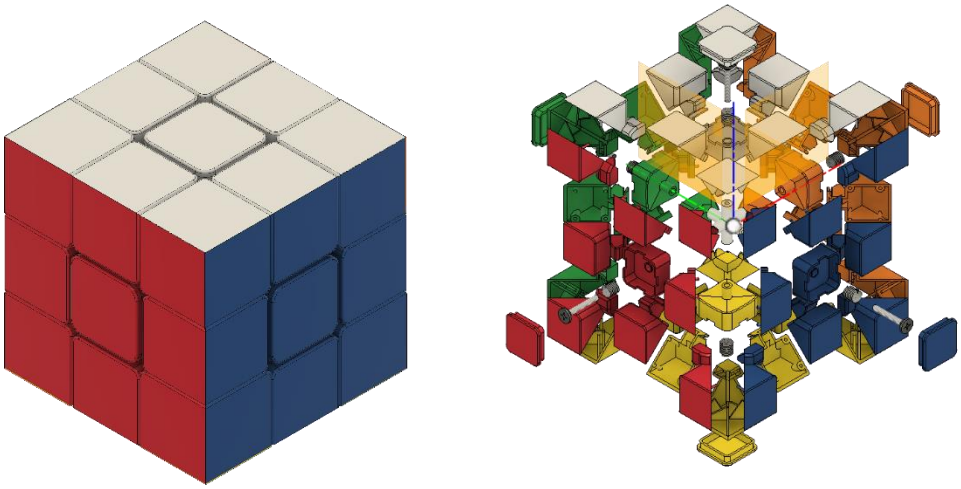
## Sketches

### Orthogonal View





Isometric View



# Improvements

## The Idea

Although the Rubiks Cube is a relatively simple, there are some focal points to consider when looking for ways to improve. Things like reducing friction and spinning layers faster are improvements for speed cubers. In the manufacturing process, ideas to improve are to reduce the number of parts, making assembly easier, and simplifying parts further.

## The Plan

In order to implement these ideas, manufacturers can edit the pieces' surface for a smoother finish, add magnets inside the pieces to help them snap together (making layers turn easier), using magnets to create tension instead of springs (reducing friction), using single mold injection pieces to increase durability of the pieces, and also potentially adding plates for the customizability of different colors of images to what the cuber desires.

# Conclusion

## What went well?

Disassembly of the Rubik's cube was easy, as it does not require tools. The report follows a similar format to the previous engineering report and also an instruction manual that I created for an internship. The PowerPoint also went very well, using similar information from my report to add to my presentation but made more digestible to explain the mechanism simply.

## What didn't go well?

Something that didn't go well was the fitment of the half and thirds pieces after being taken apart several times. In the beginning, the pieces fit well but near the end the fitment was looser and could come apart by itself. Another thing that didn't go as well as I would have hoped was the Fusion360 modeling. Modeling the pieces was fine but what became difficult was creating the assembly and having constraints for the movement and the joints.

# Sources

https://rubiks.com/en-US/#about

https://ruwix.com/the-rubiks-cube/notation/

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