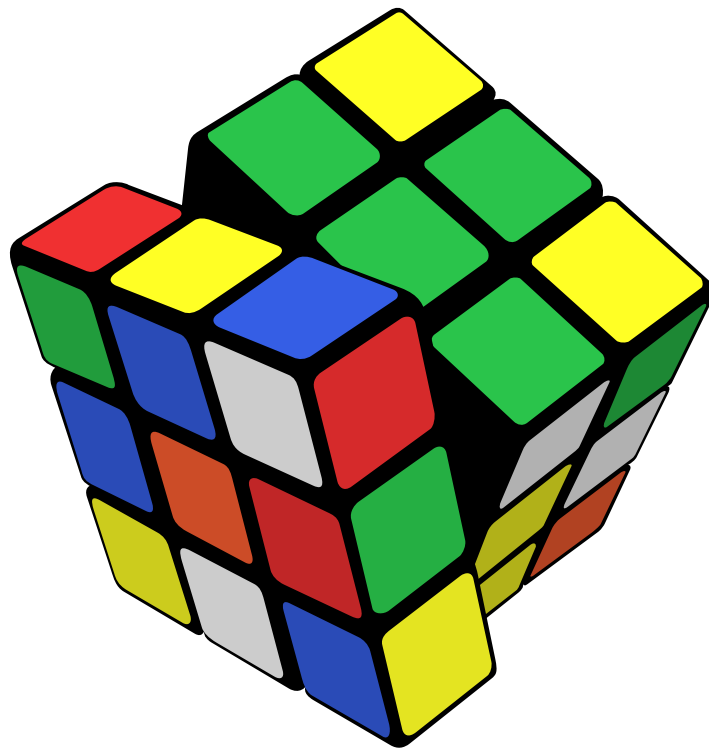

Rubik's Cube



OWNER'S MANUAL

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1 Introduction

The Rubik's Cube is a three-dimensional tactile and visual puzzle contained within a $3 \times 3 \times 3$ cube. Each face of the cube can be swivelled independently; the goal of the puzzle is to find a pattern of rotations that leads to a cube where each face is of a uniform, distinct colour. The puzzle tests spatial awareness, visual perception, and dexterity.

It was invented by Hungarian professor of architecture Ernő Rubik in 1974; at the time, Rubik was trying to create an object that could stay intact even as its parts were allowed to move freely. When, after scrambling the object he had made, he found that he could not easily restore its original configuration, he realised its potential as an intriguing puzzle. It was originally patented and marketed as the 'Magic Cube' (Bűvös kocka) in Hungary; however, after failing to secure an international patent, Rubik renamed it the 'Rubik's Cube', in order to gain at least a recognisable name to trademark.



Figure 1: Ernő Rubik with his creation

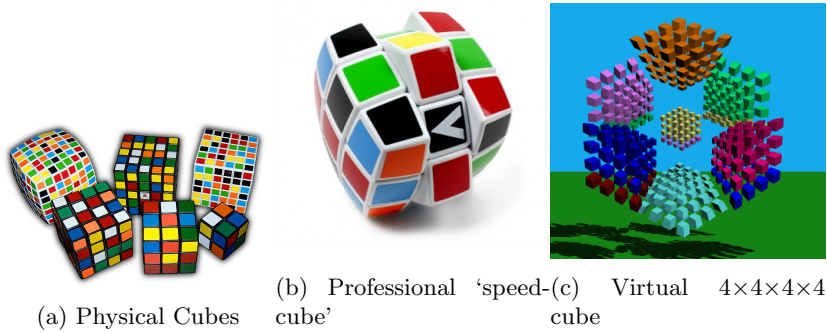


Figure 2: Cube variants

An instant hit in the West, the cube became an icon of the '80s, inspiring a number of contests and clubs. It also spun-off a number of derivative puzzles, from the $4 \times 4 \times 4$ 'Rubik's Revenge' to the $17 \times 17 \times 17$ 'Over The Top'. Further, computer modelling has allowed enthusiasts to play with variants that would be impractical (hundreds or thousands of cubelets) or even impossible (higher-dimension cubes) to build in real life.

The standard cube remains the world's best-ever selling toy, with over 350 million units sold to date. Despite being past the height of its popularity, interest in the cube has endured as mathematicians continue to look for an optimal solution to the puzzle, and an enthusiastic 'speedcubing' community solves the cube faster and faster (with the world record currently at 5.55 seconds).

The standard cube is composed of 26 pieces, also called 'cubelets':

6 Centre Pieces These pieces are at the centres of the cube faces. They feature one colour each. As can be seen in Figure 3, these pieces are always stationary relative to one another.

12 Edge Pieces Edge pieces are located in between two centre faces. They have two colours each, which determine the final position of the piece¹. These rotate around the centres.

8 Corner Pieces These are located at the corners of the cube, and have three colours each. As with edge pieces, these colours determine the final position of the piece².

This gives a total of $6 \times 1 + 12 \times 2 + 8 \times 3 = 9 \times 6 = 54$ facelets.

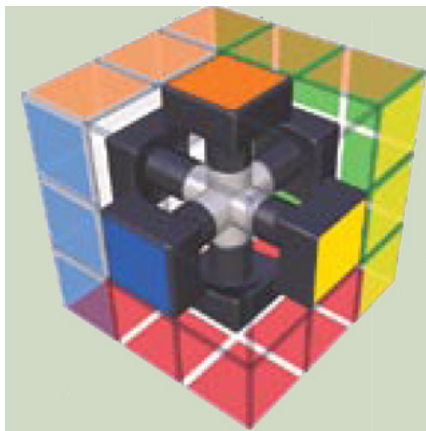


Figure 3: Cutaway Diagram

¹For example, in Figure 3, the blue-orange edge would go between the blue and orange centres. Since blue and green are opposite to each other, there is no blue-green edge.

²The blue-orange-yellow corner goes between the blue, orange and yellow edges. There is no blue-orange green corner.

2 Description

2.1 Overall Description

Dimensions 57 mm \times 57 mm \times 57 mm

Weight 100 g

Material Hard plastic

Appearance Black; individual facelets are coated by a brightly coloured sticker to differentiate the faces.

2.2 Description of Parts

2.2.1 Central Core

The central 3D cross holds the cube together. It has a yoke(see Figure 4a), along which are attached the six centre facelets(see Figure 4b). The resultant part is shown in Figure 4c.

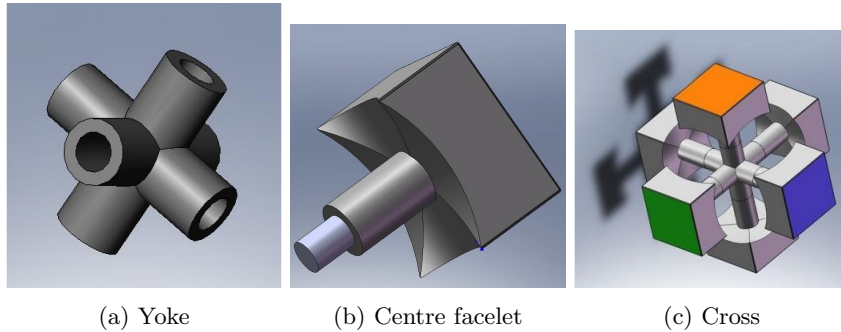


Figure 4: Core

2.2.2 Exterior Facelets

Surrounding the cross described in 2.2.1 are edge(Figure 5a) and corner(Figure 5b) cubelets, with two and three facelets respectively. They feature extrusions that lock them to the core, while still allowing them to be manipulated easily.

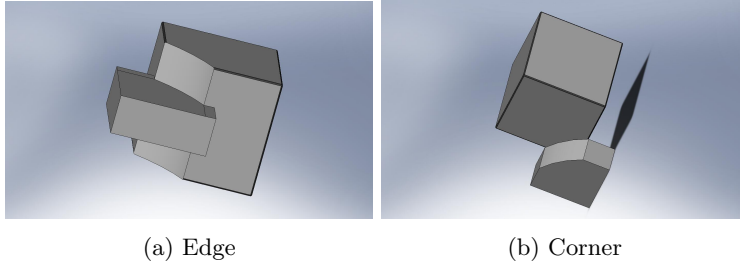


Figure 5: Exterior facelets

3 Assembly

Assembly of a dismantled cube requires the following steps:

1. Centre facelets are attached to the yolk via rivets to create the core (2.2.1).
2. Corner cubelets are locked in place via their extrusions.
3. Edge pieces are locked in.
4. Steps (2) and (3) are repeated layer-wise until the cube is complete.

This process is shown in Figure 6.

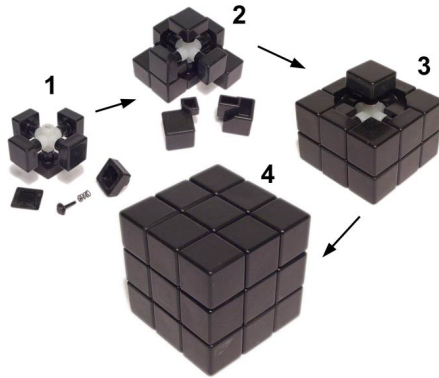


Figure 6: Assembly

4 Process

This section presents the ‘Layer Method’ for solving the cube. This algorithm is far from optimal, but is easy for beginners to learn.

Matters of notation This section utilises standard Rubik’s Cube notation to describe the solution. Consult Appendix A for information on this notation.

4.1 Cross

4.2 Corners

4.3 Middle Layer

4.4 Top Cross

4.5 Top Layer

5 Conclusion

A Algorithm Notation

The Rubik’s Cube community has developed a standardised notation to efficiently represent moves. Each face of the cube is assigned a letter, and rotations of faces are represented by their corresponding letters followed by some modifiers.

- A single letter (Eg. F) means the face must be turned clockwise by 90° .
- A letter followed by a prime (Eg. R') means the face must be turned *counter*-clockwise by 90° .
- A letter followed by ‘2’ (Eg. U2) means the face should be turned 180° . In this case, the direction of rotation does not matter.

Note that these moves are always relative to the face that the solver is looking at; see Figure 7. These individual moves can be concatenated to produce move

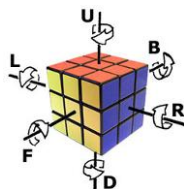


Figure 7: Move notation

sequences, such as the very commonly used ‘corner algorithm’, $FRUR'U'F'$. Giving such commonly used algorithms names allows one to recognise algorithms that one has already learnt.