Professor's Cube

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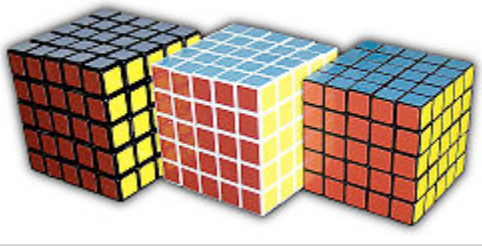
The **Professor's Cube** is a mechanical puzzle, a 5×5×5 version of the Rubik's Cube. It has qualities in common with both the original 3×3×3 Rubik's Cube and the 4×4×4 Rubik's Revenge, and knowing the solution to either can help when working on the 5×5×5 cube.



Official Professor's Cube (left) V-Cube 5 (center) and Eastsheen 5x5x5 (right).

Contents

- 1 Naming
- 2 Workings
  - 2.1 Durability
- 3 Permutations
- 4 Solution
- 5 World records
- 6 See also
- 7 References
- 8 External links

Naming

Early versions of the 5×5×5 cube sold at Barnes and Noble were marketed under the name "Professor's Cube," but currently, Barnes and Noble sells cubes that are simply called "5×5." Mefferts.com offers a limited edition version of the 5×5×5 cube called the Professor's Cube. This version has colored tiles rather than stickers.[1] Verdes Innovations sells a version called the V-Cube 5.[2]

The V-Cube 5 in original packaging.

Workings

The original Professor's Cube design by Udo Krell works by using an expanded 3×3×3 cube as a mantle with the center edge pieces and corners sticking out from the spherical center of identical mechanism to the 3×3×3 cube. The non central center pieces are fitted into spaces on the surface of the 3×3×3 mantle, and the non central edges slotted between them. All non-central pieces have extensions that fit into allotted spaces on the outer pieces of the 3×3×3, which keeps them from falling out of the cube while making a turn. The fixed centers have two sections (one visible, one hidden) which can turn independently. This feature is unique to the original design.[3]

Scrambled.

The Eastsheen version of the puzzle uses a different mechanism. The fixed centers hold the center cubelets next to the central edges in place, which in turn hold the edge cubelets. The non-central edges hold the corners in place, and the internal sections of the corner pieces do not reach the center of the cube.[4]

The V-Cube 5 mechanism, designed by Panagiotis Verdes, has elements in common with both. The corners reach to the center of the puzzle (like the original mechanism) and the center pieces hold the central edges in place (like the Eastsheen mechanism). The middle edges and center pieces adjacent to them make up the supporting frame and these have extensions which hold rest of the pieces together. This allows smooth and fast rotation and creating arguably the fastest and most durable version of the puzzle. Unlike the original 5×5×5 design, the V-Cube 5 mechanism was designed with speedcubing in mind.[5]

A disassembled Professor's Cube.

A disassembled V-Cube 5.

A disassembled Eastsheen cube.

Durability

The original Professor's Cube is inherently more delicate than the 3×3×3 Rubik's Cube due to the much greater number of moving parts. It is not recommended that it be used for speedcubing. The puzzle should not be excessively forced to twist and it must be aligned properly before twisting to prevent damage.[6] It is far more likely to break due to twisting misaligned rows. If twisted while not fully aligned, it may cause the pieces diagonal to the corners to almost fully come out. It is simply fixed by turning the face back to where it was, causing the piece to go back to its original position. Excessive force may cause the colored tile to break off completely. In such a case, the puzzle will not fall apart, but a colored square would be gone. Both the Eastsheen 5×5×5 and the V-Cube 5 are designed with different mechanisms in an attempt to remedy the fragility of the original design.

An original cube with a misaligned center. This cannot occur on the Eastsheen or V-Cube puzzles.

Permutations

There are 98 pieces on the exterior of the cube: 8 corner cubelets, 36 edge cubelets (two types), and 54 center cubelets (48 movable of two types, 6 fixed).

Any permutation of the corner cubelets is possible, including odd permutations, giving 8! (40,320) possible arrangements. Seven of the corner cubelets can be independently rotated, and the eighth cubelet's orientation depends on the other seven, giving 3^7 combinations.

Assuming the center cubelets of each colour are indistinguishable, there are 24! ways to arrange each type, divided by $4!^6$. This reducing factor results from the fact that there are 4! ways to arrange the four cubelets of each color, raised to the sixth power because there are six colors. The total permutations for all of the movable center cubelets is $(24!/(4!^6))^2$ or $24!^2/4!^{12}$.

The 24 outer edge cubelets cannot be flipped, since the interior shape of those pieces is asymmetrical. The two cubelets in each matching pair are distinguishable, since the pieces are mirror images of each other. Any permutation of the outer edge cubelets is possible, including odd permutations, giving 24! arrangements. The 12 central edge cubelets can be flipped. Eleven can be flipped and arranged independently, giving $12!/2 \times 2^{11}$ or $12! \times 2^{10}$ possibilities (an odd permutation of the corner cubelets implies an odd permutation of the central edge cubelets, and vice versa, thus the division by 2). There are $24! \times 12! \times 2^{10}$ possibilities for the inner and outer edge cubelets together.

This gives a total number of permutations of

$$\frac{8! \times 3^7 \times 12! \times 2^{10} \times 24!^3}{4!^{12}} \approx 2.83 \times 10^{74}$$

The full number is precisely 282 870 942 277 741 856 536 180 333 107 150 328 293 127 731 985 672 134 721 536 000 000 000 000 000 possible permutations[7] (about 283 duodecillion on the long scale or 283 tresvigintillion on the short scale).

Some variations of the Professor's Cube have one of the fixed center pieces marked with a logo, which can

be put into four different orientations. This increases the number of permutations by a factor of four to 1.13×10^{75}, although any orientation of this piece could be regarded as correct.

Solution

People able to rapidly solve puzzles like this usually favour the strategy of grouping similar edge pieces into solid strips, and centers into one-colored blocks. This allows the cube to be quickly solved with the same methods one would use for a 3×3×3 cube. As illustrated to the right, the fixed centers, middle edges and corners can be treated as equivalent to a 3×3×3 cube. As a result, the parity errors sometimes seen on the 4×4×4 cannot occur on the 5×5×5 unless the cube has been tampered with.

An original Professor's Cube with many of the pieces removed, showing the the 3×3×3 equivalence of the remaining pieces.

Another frequently used strategy is to solve the edges of the cube first. The corners can be placed just as they are in any previous order of cube puzzle, and the centers are manipulated with an algorithm similar to the one used in the 4×4×4 cube.

World records

The current record for solving the Professor's Cube in an official competition is 1 minute 7.25 seconds, set by Dan Cohen at the *Big Cubes Summer 2009*.[8]

Dan Cohen holds the current world record for an average of five solves, with the average of 1:16.75, set at the UPenn Spring Open on March 21 2009.

See also

- Pocket Cube – A 2×2×2 version of the puzzle
- Rubik's Cube – The original version of this puzzle
- Rubik's Revenge – A 4×4×4 version of the puzzle
- V-Cube 6 - A 6×6×6 version of the puzzle
- V-Cube 7 - A 7×7×7 version of the puzzle
- Combination puzzles

References

1. ^ Meffert's Professor's Cube (http://www.mefferts.com/products/details.php?lang=en&category=13&id=238)
2. ^ Verdes' Innovations V-Cube 5 page (http://www.v-cubes.com/pr_5.php)
3. ^ United States Patent 4600199 (http://www.freepatentsonline.com/4600199.html)
4. ^ United States Patent 6129356 (http://www.freepatentsonline.com/6129356.html)
5. ^ United States Patent 20070057455 (http://www.freepatentsonline.com/y2007/0057455.html)
6. ^ Rubi's 5x5x5 Cube notice section (http://www.rubiks.com/Shop/Products/Rubiks%205x5%20Cube%20Hex%20Packaging.aspx)
7. ^ Cubic Circular Issues 3 & 4 (http://www.jaapsch.net/puzzles/cubic3.htm#p18) David Singmaster, 1982
8. ^ [1] (http://www.worldcubeassociation.org/results/regions.php) 5x5x5 Cube.

External links

- How to solve Professor's Cube (http://www.bigcubes.com/5x5x5/5x5x5.html)
- Professor's Cube text solution (http://wiki.playagaingames.com/tiki-index.php?page=5x5x5+Cube+Solution)
- Professor's Cube interactive solution (http://www.rubiks-zauberwuerfel.de)
- Courtney McFarren's Professor's Cube solution (http://www.geocities.com/abcmcfarren/math/rp/RubPro1.htm)

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