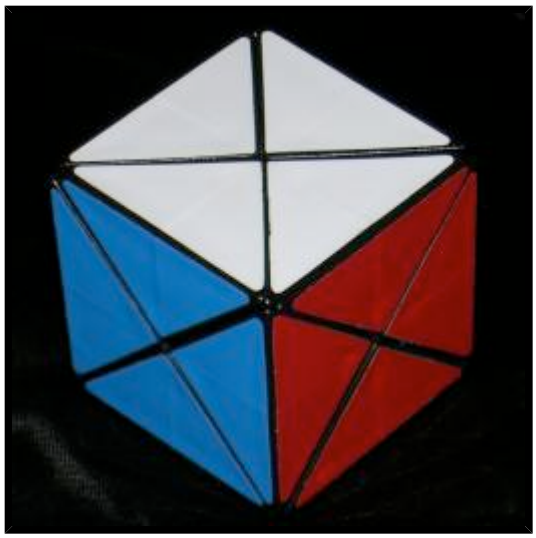
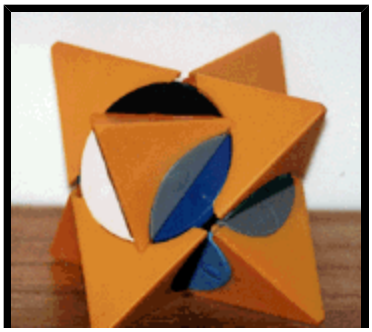
Jaap's Puzzle Page

# Dino Cube / Rainbow Cube / Brain Twist





The Dino Cube is a cube shaped puzzle, and like the Skewb, it has eight axes of rotation centred around the corners. Its cutting planes go diagonally through the square faces, cutting off triangular pyramidal corners. There are twelve moving pieces, one on each edge of the cube. It is called a dino cube because it originally had pictures of dinosaurs on the sides. Versions with 6 colours (pictured above) were also made, as well as with only 4 or 2 colours.

The second puzzle pictured above is the Rainbow Cube. It has the shape of a cuboctahedron. It is very much like a Dino Cube in which the corners have been cut off, giving it 8 triangular faces as well as 6 square ones. The puzzle still has only 12 moving pieces, but now there are also stationary centres in the triangular faces. There are two colour schemes. One has 14 colours, the other has only 7 colours with opposite faces the same colour. As the puzzle with the 7 colour scheme does not have any identical pieces, the two colour schemes give puzzles of the same difficulty.

The Brain Twist is a new puzzle by Hoberman. The third picture above shows what it looks like when unfolded in its star shape. To make a move, the points of the star are pushed together causing it to fold into a tetrahedron shape, after which the four corners of the tetrahedron can be twisted. You can unfold it and then fold it in the other direction to get a different tetrahedron with four new corners to twist. The equivalence with the dino cube is most easily seen when the puzzle is in its star shape, and imagining the effect of a twist of three pieces around a corner.
There are two solution patterns - one with each tetrahedron face a single colour, and one with each tetrahedron corner a single colour. The second solution does not look as nice when in star shape however.
It was patented by Charles Hoberman and Matthew Davis on 12 May 2005, US 2005/098947.

Jackpot, also known as Platypus, is a new puzzle from Meffert's, and the fourth picture above shows a prototype version. Unlike the other puzzles on this page, on the Jackpot the eight axes are not identical. It is not cube shaped but is based on the tetrahedron, with the corners extended in a triangular cylindrical shape. There are four large hexagonal faces, marked with card suits, as well as four small triangular faces, marked with J, Q, K, and A card values. The pieces are all similarly marked on their sides. For an extra challenge, on some versions of the Jackpot the hexagonal faces also have coloured marks along their edges, so that their orientations matter.
It was patented by Yusuf Seyhan on 16 January 2003, WO 03/004117.

There is also another puzzle that is equivalent to the Dino Cube, but I do not know much about it. It is in the shape of a Stella Octangula, of which the corners can rotate. There are small pieces in between them along the edges of the internal octahedron, and the three pieces around each tip form a circle on the surfaces of the adjacent tips. Each circle should be of one colour. I have seen this one in David Singmaster's collection, but his is of a different colour than the one pictured above.

If your browser supports JavaScript, then you can play with the Dino Cube by clicking the link below:

**JavaScript Dino Cube**

## The number of positions:

There are 12 moving pieces, which seemingly have 2 possible orientations giving at most $12!\cdot 2^{12}$ positions. This limit is not reached because

- The pieces cannot actually be flipped ($2^{12}$)
- The pieces must have an even permutation (2)
- On the Dino Cube, Brain Twist, and Stella, the orientation of the puzzle is immaterial (12)

This leaves 11!/2 = 19,958,400 positions on the Dino Cube, Brain Twist, and Stella, and 12!/2 = 239,500,800 positions on the Rainbow Cube and standard Jackpot.

Some versions of the Jackpot puzzle have colours on the sides of the hexagonal faces, making their orientation visible. As these faces can be twisted independently, there are $3^4$ times as normal, viz. $3^4\cdot 12!/2$ = 19,399,564,800 positions.

The Dino Cube actually has two solutions, which are mirror images of each other. This is similar to the two solutions of the Brain Twist.

I have calculated how many moves each position of the Dino Cube needs to solve, as shown in the table below. One column was calculated with the assumption that there are two solutions (mirror images of each other), the other column is based on the assumption that you want a particular one of those. The Rainbow cube was calculated by Claude Crépeau and Thanh Vinh Nguyen, and is shown in the last column.

| Moves | Dino / Brain Twist 2 Solutions | Dino / Brain Twist 1 Solution | Rainbow Cube Jackpot (no colours) |
|---|---|---|---|
| **0** | 2 | 1 | 1 |
| **1** | 32 | 16 | 16 |
| **2** | 320 | 160 | 160 |
| **3** | 2816 | 1408 | 1408 |
| **4** | 23424 | 11712 | 11712 |
| **5** | 180084 | 90912 | 90912 |
| **6** | 1227084 | 640192 | 644756 |
| **7** | 6167660 | 3740838 | 4070826 |
| **8** | 10926002 | 11138597 | 21433009 |
| **9** | 1429972 | 4313963 | 76410122 |
| **10** | 1004 | 20577 | 109897795 |
| **11** | | 24 | 26611502 |
| **12** | | | 328215 |
| **13** | | | 366 |
| **Total** | **19958400** | **19958400** | **239500800** |

In Sloane's On-Line Encyclopedia of Integer Sequences these are included as sequences A079766, A079767, and A079768.

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## Links to other useful pages:

Uwe Mèffert's pages has the Jackpot available.
Bethel, are the Japanese manufacturers of the Rainbow Cube.

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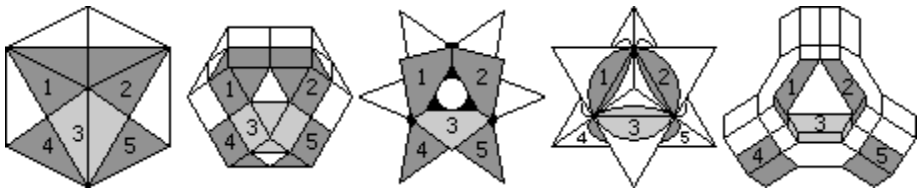
## Solution:

These are very easy puzzles to solve. There is really only one easy sequence of moves that you need to be able to do. Consider two adjacent axes on the puzzle, with the five piece positions they contain numbered as shown here:

1 2
3
4 5




You are trying to put the correct pieces at positions 1 and 2, and you haven't yet solved 3, 4 and 5 yet (though it is quite possible that one or more of them happen to be correct, ignore them).
Solving the first piece, at position 1 is trivial, since you can just put it there without disturbing previously solved pieces.
Next, you want to put the correct pieces at position 2, without disturbing the piece at 1.

1. First bring the piece belonging at 2 to position 4 or 5, without disturbing any of the pieces you have previously solved.
2. Then turn the top face/corner clockwise, putting the piece that currently is at position 2 to the intersection at position 3.
3. Turn the bottom face/corner to bring the piece belonging at 2 to position 3, replacing the old piece.
4. Turn the top face/corner anti-clockwise, back to its previous position, which puts the correct pieces at both 1 and 2.

Once you understand this simple technique, the puzzle can be easily solved by solving the pieces in the following order:

a. Solve three adjacent pieces that share an axis (a triangular face in the Rainbow Cube, three pieces at one corner in the Dino Cube, etc).
b. Solve the six pieces that are adjacent to the first three you solved. You need not move any of the first three solved pieces at all.
c. Solve the last three pieces (which are the ones directly opposite the first three). This is trivial, as you only need at most a single move to do this (though see note below).

Sometimes however it is hard to recognise which piece belongs where. On the Rainbow Cube each colour is used on opposite faces of the puzzle, which means that each piece also has a mirror image twin. If you just keep track only of the colours of the triangular faces, then you cannot go wrong as the mirror piece will have its colours swapped if you try to use it instead. On the Dino Cube adjacent pieces have only one colour in common, so it seems that you could put the wrong pieces next to each other. This is not the case however - if you try to place the wrong piece, it will seem to be flipped.

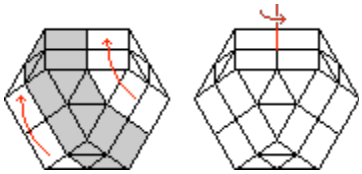
On the Brain Twist it is easy to get confused because of the constant need to flip the puzzle inside out, but this puzzle has another neat twist in store. It may happen that you solve the puzzle completely but for two pieces that need to be swapped. This is unfortunately not possible (it is an odd permutation and every move is an even permutation). What has happened is that you have built the colour pattern in mirror image. You have to practically re-solve the whole puzzle - choose any face you had solved, swap two of its pieces, and continue from there.

If you have a puzzle on which the face orientations are visible, then the techniques outlined above are not quite sufficient. With a little care you can ensure the face orientations are correct of all but the last face (step c above). If you are solving a Jackpot where the hexagonal faces are marked, then you can simply leave an unmarked triangular face till last instead.

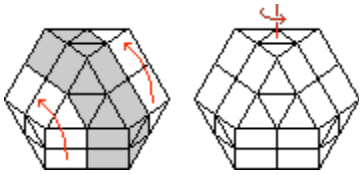
## Pretty Patterns and other moves:

**Spot Patterns**
The rainbow cube has two types of spot patterns, patterns in which only the triangular centres have a different colour. One has 8 spots, the other only 6 spots.

The 8 spot is made like this: Hold the puzzle with a square on top. Make a slice move, i.e. turn any triangular face clockwise, and its opposite face anti-clockwise (so the two faces have actually moved as a unit). Turn the whole puzzle a quarter turn around the vertical axis. Repeat this a number of times. After 6 or 10 times (depending on the direction you turn the puzzle) you will get the 8 spot.



The 6 spot is done much the same way, except that a triangular face is on top, the slice move is done on any of the other faces, and the puzzle is rotated through 120 degrees each time. After doing this 8 or 10 times, depending on the direction, the 6 spot will appear.



**Swapping between solutions**

The Dino Cube has two solutions which are mirror images of each other. To change a solved Dino Cube to show the other solution, perform the following move sequence:
urb urf urb' ulf urf drb' urb' ulb dlb' dlf.
There is a longer method which is much easier to remember:
(urb ulf drf dlb) (urf' ulb' drb' dlf') (urb ulf drf dlb).
This first turns one tetrad of corners clockwise, then the other tetrad counter-clockwise, and then the first tetrad clockwise again.
The same method works on the Brain Twist to swap from the faces-solution to the corners-solution, and vice versa. Simply twist all corners clockwise, flip it, twist all corners counter-clockwise, flip again, and turn all corners clockwise.

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