CubiChronicles

Celebrating 25 years of the Rubik’s Cube!

Inside:
Great Solving Methods!

Learn how to take apart a Cube and put it back together!

Plus: Complimentary Rubik’s Cube!
Welcome to the inaugural issue of CubiChronicles! We are proud to bring you this new magazine, a publication we hope will excite all Rubik’s Cube lovers and addicts! The Rubik’s Cube is a regular but perplexing feature of our childhood toy boxes, and this periodical hopes to unveil the mystery and discover the fascinating magic of the Cube! 2003 is also a special year as it marks the Rubik’s Cube’s 25th birthday, and the World Rubik’s “Games” Championships will be held in Toronto, Ontario, Canada on August 23-24, 2003. This event will see the largest group of Cube lovers and the best Speed Cubists gathered, rubbing shoulders and exchanging precious cubing tips, and we, the magazine team, look forward to seeing old records broken, new puzzles solved and lasting friendships forged at the event!
As this is the premiere issue of CubiChronicles, we are taking a holistic and friendly approach towards introducing the Rubik’s Cube. The aim of the magazine is to engage both Cube veterans and Cube amateurs, and we hope to do this by writing the articles in a reader-friendly manner. You will not find the abject use of mathematical language in this magazine; instead, what will be presented will be a wide array of interesting articles written and explained in simple layperson terms, so as to ensure that everyone who picks up the magazine will be able to comprehend and enjoy it equally!

A complete introduction to the magic of the Rubik’s Cube will be given in this issue. Articles range from the Cube’s history to a simple solution of the Cube, an activity you can follow using the complimentary Cube that we are giving away with the Issue! (There are four different Cube designs so collect them all!) Enjoy reading about other Rubik toys besides the original 3x3x3 Cube, and take part in our quiz to find out how much you know about the Cube!

Excited? Then turn the page and enjoy your journey with the amazing Rubik’s Cube, just as we the magazine team have had immense fun putting this magazine together for you!

Love,

Editor 🌸
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1) History of the Cube
Read about the illustrious history of the Rubik’s Cube, from its imaginative origins to the troubles Ernö Rubik faced in bringing his invention to life. You’ll never look at the seemingly simple 3x3x3 Cube in the same way again!

2) Dismantling your Cube
Ever wondered what your Cube looks like on the inside? We’ll show you how to dismantle the Cube like the pros do, and most importantly of all, how to put it all back together!

3) Inner Workings of the Cube
The biggest problem Ernö Rubik faced in bringing his conception to life was not its outer design, but to find an inner mechanism that will allow the Cube to be twisted and turned without “tangling”. Read about the amazing inner workings of the Cube here.

4) Various Rubik’s Cube Sizes
Think the Rubik’s Cube comes only in 3x3x3? That’s where you’re wrong! The Cube comes in a variety of sizes and shapes that will boggle your mind! You think you had problems solving the
3x3x3? Well, meet the Rubik’s Revenge and the Professor’s Cube! Find out more right here!

5) Standard Notation and a Step-By-Step Solution to the Cube

Learn about algorithms, the common mathematical “language” Cubists around the world use to communicate ideas and solutions. Proceed to solve your own jumbled up Cube with our illustrated step-by-step instructions. Have fun!

6) Cube Trivia

Read about interesting facts and trivia about the Rubik’s Cube! Impress your friends with your newfound knowledge!

7) Other Rubik’s Toys

Did you know that Rubik has a whole range of other mathematical toys besides the Cube? Meet the Dodecahedronal puzzle called the Megaminx! And how about the Pyraminx, the Pyramorphix, the Octagonal puzzle and Square 1? Get acquainted with all of them here!

8) Rubik’s Quiz

Find out how much you now know about the amazing Rubik’s Cube by trying our Rubik’s Quiz!
**History of the Cube**

**Official Birth Date:** 1974 (1st prototype created.)

**Place:** Budapest, Capital of Hungary

**Inventor:** Ernő Rubik (A lecturer at the Department of Interior Design at the Academy of Applied Arts and Crafts in Budapest.)

The Cube may have been given birth in 1974, but the processes that led to its creation started a few years earlier. Ernő Rubik had a love for geometry and the study of 3D forms. He was very much interested in construction and exploring the many possibilities of combinations of forms, both theoretically and hands on.

In his teaching years, Ernő Rubik liked to communicate his ideas through the use of models for easy visualization and experimentation on the students’ part. It was here that he realized that even the simplest elements or shapes, ingeniously multiplied and manipulated, can be transformed into a whole lot of other interesting forms. This realization was the first stepping-stone to the creation of the Cube.

In addition, other great classical puzzles preceding the Cube probably give him aspirations in making the Cube. The Tangram, originating from ancient China, which consists of only 5 triangles, a square and a parallelogram, yields a wide array of figures (such as animals and others). The pentomino, invented by Solomon W Golomb, forms 12 possible shapes which look like the letters V, T, W, X, U, Z, P, F, I, N, Y and L. Each shape is made up of 5 unit squares (or sometimes cubes) joined along their edges. Pentomino challenges people to construct various rectangles using the 12 shapes. Then, there is the Piet Hein’s Soma Cube, a 7-piece puzzle, to be assembled into 3x3x3 cube or other puzzle figures (including “The Tower”, “The Castle” and “The Church”). This Soma Cube was to give Rubik the idea of making a 3D puzzle cube. Next comes Sam Loyd’s 15 puzzle, with its tiles numbered 1 to 15 in order from left to right and from top to bottom, leaving an empty square at the bottom right. This empty space allows movement for the shuffling (‘messing up’) as well as unscrambling of the tiles. In view of all these puzzles, Rubik wanted to create a 3D puzzle, one that has, not only a great combination of forms, ever more mentally challenging but also ONE, SELF-CONTAINED WHOLE, that does not change shape easily with the twisting and turnings of the Cube.

However, he met with many problems. First, it seemed impossible to have the 3x3x3 cube rotating on an axis (3-axial rotation). So, he tried to work on a simpler 2x2x2 cube instead. The attempt to use elastic rubber to hold the 8 elements failed. Alternatives such as magnets and the tongues and grooves system failed too. Rubik had to deal with the complexity of the movements in between junctions of each element from a totally new perspective.
Then came one fine day, he suddenly had his inspiration as he sat by the water bank watching the river flow. He observed that the sharp edges of some pebbles are eroded by the water current into smooth rounded shapes over time. This gave him the idea to have the same rounded architecture for the interior of the Cube. The interior of the Cube basically had to be cylindrical. Also, for ease of manipulation, the tightness and looseness between the elements of the Cube had to be of a certain tolerance. There had to be a balance. Next came the experimentation of colours for the Cube. Initially, he had 54 (3 x 3 x 6 sides) elements painted with decorative designs, numbers, or symbols. He tried a number of colour combination for the Cube too. Eventually, he settled on having 6 distinct colours, one colour for each side/face of the Cube.

The Cube was completed. Ernő Rubik then demonstrated to his students and let some of his friends played with it. Everyone was hooked onto the Cube as they tried to solve the puzzle. This led to the thought of producing it at commercial level.


1978: Invention of the Cube spread by word of mouth.

1979: There were many people devoted to playing the Cube in Hungary.

Dr Laczi Tibor, born in Budapest, employed by a major German computer manufacturer came across the Cube on his visit to Hungary. Believing in its potential consumer appeal, he brought it to the Nurnberg Toy Fair in Feb 1979. He met Tom Kremer, a successful toy and game inventor, whose mother tongue was also Hungarian, and who ran a licensing company, Seven Towns Ltd, based in London.

They decided to bring the toy, the Cube, to an international level of recognition. Dr Laczi was to pave the way in Hungary. Tom Kremer was to find a toy manufacturer for the Cube, probably a major international company. He would need its help to market and distribute the Cube to really realize the Cube’s full commercial potential.

June 1979: David Singmaster, an English mathematician, wrote a newspaper article on the Cube: an article in Scientific American, with a cover picture, by Douglas Hotstadter, an acknowledged authority in the field of Recreational Mathematics.

Sep 1979: Tom Kremer persuaded Stewart Sims, Vice president of Marketing of the Ideal Toy Corporation, to come to Hungary to see the Cube in play. After much negotiation, an order of 1 million Cubes was signed.


The Cube becomes one of the all time classic toys. It becomes a family puzzle and game which bears the stamp of the genius who created the greatest 3D puzzle the world ever know.
When I set my mind on having my own hands-on experience after seeing a Cube being taken apart @ [http://www.eightyeightynine.com/games/rubiks-cube-cheating.html](http://www.eightyeightynine.com/games/rubiks-cube-cheating.html), I started my search for a cheap Cube for my surgical attempts. Traipsing down Chinatown, I found one in one of those quaint shops, selling other toys past the fad of today’s children. I remember being amused as I realised that printed on the square faces of this Cube, were… …

LUOHAN FISHES!
Talk about being innovative and keeping up with the times for this toy of the 80s. 😊

Why do I bother to figure out how to take apart a Rubik’s Cube? Maybe as the above URL suggests, it is the last resort for desperados who cannot solve the Cube. Other than this less-than-honourable intention, I was curious to see how the interior of a Cube looks like, as well as what enables a Cube to turn in all 6 directions.

So, let’s grab a screwdriver and start the (temporary) destruction of the Cube!

This is the picture of my Luohan fish Cube in one piece before going under the surgical (screwdriver) knife.

To start, use a blunt screwdriver as suggested by the eightyeightynine website. Slide the blade under the top (looking horizontally) layer’s middle cubie (do not go for any other cubies as the entire Rubik’s Cube will be permanently damaged), and gently push upwards. Do not use brute force. Gradually push up till the cubie pops out.
After removing the middle piece…

… the corner ones could be slid out easily.

If there is difficulty in removing other cubies, remove the middle ones at the sides first. Do not attempt to remove the centre cubie; it is inter-connected to 5 other cubies on axes in 5 other directions.

After the removing all the pieces at the sides, a cylinder can be seen under the centre cubie.
Remove cubies from the top and bottom layers, and lay each pile separately aside. Then proceed to remove the cubies from the middle layer, which should only have 4. Lay them aside in another pile.

Voila! This is the Rubik’s Cube in pieces! Talk about Rubik’s Revenge (the 4x4x4 Cube), hehehe…

In the middle is the axes “skeleton” of the Cube, with a centre cubie on each of the 6 arms.

To reassemble the Cube is harder than taking it apart (sorry for the delayed warning :p)

Firstly, replace the cubies for the middle layer. Should you mix them up, a good guide is that they should only have two colours on the cubie, and depending on the colour scheme of your Cube, you follow the colours of the side arms and fix them.

In my dear Luohan fish Cube’s case, I have to be particularly careful when fixing back the cubies, in case the fishes on each face points in different directions! This is possible because for each centre cubie on the arm, they can be rotated. As a precaution, I choose a corner cubie as a guide, and turn my centre fish to follow it.
Secondly, slide the corner cubies back in first. Then slowly push the middle cubies back in.

Congratulations if your Cube survived your dismantling! Hooray!
Before the birth of the Cube, Ernö Rubik thought up many ideas to allow the Cube to turn smoothly and yet stay in one piece. In late 1974, it seemed that constructing a working model would be nearly impossible. None of the designs at the time could solve the complex interaction of the elements.

His initial ideas ranged from using magnetic field to elastic bands to hold the cubes together. In the end, he thought of having the blocks hold themselves together by their shape. Hence, he hand-carved and assembled the little cubies (which are the individual little cubes) together. He also gained inspiration from smooth pebbles on the shores of the Danube - this introduced the idea of cylindrical shapes and axes into the cube.

After dismantling the Cube, we decided to see if arranging the parts in different ways would give us some clue as to how the Cube actually works internally. Although we cannot give an exact account, our findings did shed some light into the cracks of the Cube.

By arranging the bottom layer of cubies together, we actually get a circular structure in the middle. This gives some clue that there is indeed a cylindrical structure that allows the Cube to be turned.

Pulling at one cubie on an axis, we find that there is a spring that is connected under each cube. This elasticity allows the Cube to be more easily turned, and pulls back the other cubies when in a state of rest. The grooves underneath each connected cubie will be interlocked with the grooves of the individual cubies. With part a) and b) rejected for complexity and difficulty to make accurate measurements, part c) is what you get when the grooves interlock. The axes keep the cube from falling apart.
After arranging “two towers” upon the bottom layer, we see roughly a sphere within the cube sliced off a quarter at the corner. This implies that when the entire Cube is assembled, there is actually a sphere of interlocking grooves inside.

The top view of the arranged structure shows the cylindrical structure integrated into the sphere of interlocking grooves.

The smooth rounded corners on the corner cubies was apparently inspired by the smooth pebbles. These corners allow cubies interlocked with the corner cubies to turn.
By fixing two cubies on top of the bottom layer and yet removing the middle cubie from the front, we get a cross-sectional view of the grooves involved in the interlocking process within the Cube.

Lining up the axes of cubies with the above structure, the cylindrical and spherical structure of the internal Cube is more easily seen.

Finally, we place the axes of cubies on its side in an attempt to show the spherical space between the cubies.
Offsprings of the Rubik's Cube

Following the advent of the idea of the Rubik's Cube, other cubes were to come along. Ernő Rubik patented one, which was the 2x2x2 Cube, other cubes by other innovative creators. With a new cube, there would always be something new and exciting about it to discover, but a host of difficulties like parity problems will also give headaches to a new breed of solvers. Still, some variety will add some interesting element into our boring world.

Mini Cube, the 2x2x2 Rubik's Cube

A smaller version of the Rubik's Cube, it has got alternate names like Mini Cube and Pocket Cube. It is built from 8 cubies. It is coloured on all 6 sides. As there are no face centers to use as a reference point when solving, it can be a little confusing. However, the puzzle is equivalent to the corners of the normal Rubik's Cube. An ironic element of this cube is that the construction problem of the 3x3x3 cube was solved first, before the solution was applied to the 2x2x2 cube!

The 2x2x2 cube was patented by Ernő Rubik on 29 March 1983, US4378117.

A puzzle called the pyramorphix is related to the 2x2x2 cube, except that the orientation of four of the pieces does not matter. The pyramorphix is a small regular tetrahedron where each face is divided into 4 smaller triangles.
Rubik's Revenge / Master Cube / 4x4x4 Rubik's Cube

The 4x4x4 cube was marketed in 1982-1983. This cube is built from 56 smaller cubies. It had an interior sphere with grooves in which the center pieces could slide, and a simple but ingenious blocking to prevent the interior from becoming misaligned with the exterior. Unlike the 3x3x3 Rubik's Cube, turning a face moves the face centres. Hence, centres cannot be used as a fixed reference point, so one must learn to keep the cube in a fixed reference in space. There is an additional parity problem which can leave you needing to exchange just two edge pieces. (For the Rubik's Cube, you need to exchange four edge pieces, hence solutions for solving both are different)

The 4x4x4 mechanism was patented by Peter Sebesteny on 20 December 1983, US4421311.

Professor's Cube, the 5x5x5 Rubik's cube

This 5x5x5 cubes was created by Udo Krell and later made in Hong Kong by Meffért. It was only marketed in Germany (and perhaps Japan?), where it was called “Rubik's Wahn”, with Wahn meaning illusion or delusion. This cube is built with 98 cubies. The mechanism of it is like a double-layered Rubik's cube, with the extra pieces worked in between the layers. Its solution does not introduce any new
parity problems, but obviously takes longer to solve. It allows certain patterns that cannot be obtained on the 4x4x4 cube, like the chessboard patterns on all six faces. Similar to the 3x3x3 Rubik's cube, each face has a centre piece which never moves from its spot, so these can be used as a fixed reference point, showing what colour each face should be.

The 5x5x5 cube was patented by Udo Krell on 15 July 1986, US4600199.

In a 6x6x6 cube, the corner continues to overlap the edge, but the overlap is so small to be impracticable. Remember that there are grooves interlocked between each piece of cubie with the corner cubie, so there must be sufficient space for the grooves to interlock and turn. For the 7x7x7, there is no overlap at all, hence the corner piece will fall off. One could make the inner layers of the cube thinner than the outer cubes layers to create space in order to permit making these larger cubes, but no one has done it yet.
There are 3 methods of solving the Rubik’s Cube: a) finding a way to return the Cube to the ordered pattern from any scrambled position, b) retracing the steps that landed the Cube in a particular position (theoretically), c) taking the cubies apart and rearranging them, or d) taking the stickers off and put them back in the ordered position. So maybe that is 4 ways, but we could hardly consider method d), which would be an insult to our intelligence; even method c) is only to be considered by the fainthearted, or by beginners who would like to start out again from an unscrambled position (the section on Dismantling your Cube on page 4 would have come in useful then). Fortunately for us method b), whereby you perform the movements that scrambled the Cube in the opposite direction and order, is not the only way, because it is tedious and may fail in the process. We shall now look at a).

The interesting thing about the Cube is that there is no perfect solution yet, and mathematicians have jokingly called it “God’s Algorithm” to illustrate its seeming unattainability (an algorithm is basically a method of solving a problem). Ernő Rubik was just as intrigued as other people on how to solve the Cube whilst he was designing it, and in fact was forced to solve it to prove to others that a solution did exist. He has no perfect solution himself. Since its venture into the market, Cube lovers all over the world have come up with many different ways or algorithms of unscrambling it. The possibilities are still inexhausted.

What gives the Cube its place in mathematics is partly due to the fact that the parts of the Cube stay together (unlike many other moving-piece puzzles), making it into a very elegant example of a permutation group. This is the basis for the many algorithms proposed worldwide, some of which we will introduce to you later. Another two important features are the fact that several pieces move at once and that the pieces have orientation i.e. a piece can return to its original position but in a clearly different orientation. They give the permutation group so much complexity that mathematics has to be used to understand its potential.

To make this section user-friendly to beginners, we are presenting two methods of solving with step-by-step instructions and diagrams. The first method is found on the relatively new Rubik’s website www.rubiks.com. It is chosen because there are only a few easy algorithms to master, and it can help you understand more about solving before venturing onto others and finding your preferences. Our emphasis here is not on speedcubing. The second one, which is a simple layer by layer method courtesy of Mr Christophe Goudey from his website http://www.cubeland.fr.st, is to whet your appetite even further with a rather different way of solving. Having a literal notation is advantageous as it can be used to record the moves quickly and concisely. This standard notation is the language Cube solvers in the English-speaking world share to communicate the Cube-solving algorithms. When the series of notations are followed, voila, the puzzle of the jumbled up cube can be solved. As can be seen, solving the
Rubik’s Cube is not as cryptic and difficult as it has often been made out to be. Let us start our solving journey by getting acquainted with the notation.

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**Standard Notation**

We are using David Singmaster’s notation as it is the most widely known. Each side of the Rubik’s Cube is given a different name: **F=Front, B=Back, R=Right, L=Left, U=Up, D=Down**. Sometimes you will encounter cases when the Up face is called the Top and labelled T, but this does not affect the essence of the algorithm itself.

These sides are named because of their orientation to you, not because of their colour. If you turn the cube upside down, the UP becomes DOWN, and the DOWN becomes UP, so the sides don’t retain their names. DOWN is whatever side is pointing to your feet, and UP is always pointing up. Before you start solving the cube, decide on which colour should face you and be the FRONT, and stick to this throughout the solving process to prevent confusion and mistakes.

There are only 3 types of turns that are useful: clockwise ('), counter clockwise ('), and half turns (''). The symbols in parenthesis will be what are used to differentiate between different types of turns. It is important to note that CLOCKWISE and COUNTER CLOCKWISE turns are of 90°, whereas HALF TURNS are of 180°. It does not matter if you attempt HALF TURNS in the clockwise or counter clockwise direction, as a 180° turn in either direction will end up with the same result.

Sometimes you will encounter HALF TURNS being denoted as **U2** or **U^2** instead of **U''**, as shown above, in other books or websites. This is not a cause of worry as it essentially means the same thing i.e. that the face or layer is meant to be turned 180° degrees in either the clockwise or counter clockwise direction.

Turn the front face clockwise – F
Turn the front face counter clockwise – **F’**

Turn the back face clockwise – **B**

Turn the back face counter clockwise – **B’**

Turn the right face clockwise – **R**

Turn the right face counter clockwise – **R’**

Turn the left face clockwise – **L**

Turn the left face counter clockwise – **L’**

Turn the up face clockwise – **U**

Turn the up face counter clockwise – **U’**
Turn the down face clockwise – D

Turn the down face counter clockwise – D’

Two of the same picture would mean a half-turn of a particular face, regardless of direction. For example,

means a 180° turn of the front face – F’’

When you see a whole string of notation, like an algorithm denoting UF’L”RL' for example, just break the series down into individual bite-size steps and work from left to right. UF’L”RL' simply means that you turn the Cube U, F', L'', R followed by L'. To put this even more simply, orientate the Up side of the Cube U 90 degrees in the CLOCKWISE direction, followed by the Front side of the Cube F 90° in the COUNTER CLOCKWISE direction, as denoted by F'. Next, turn the Left face of the Cube L 180° in either the clockwise or counter clockwise direction, as denoted by L''. Follow the same instructions for R and L', and you will have completed that line of algorithm instructions! Easy isn’t it?!

Now that we have mastered Rubik’s notation, let’s practice our newly acquired skills! You can follow the process with the complimentary Rubik’s Cube given when you purchased this magazine. Remember to follow the steps at your own pace, and to break the instructions down into further bite size bits if you do not understand. Most importantly of all, be patient and have fun!

**Solving the Rubik’s Cube**

To quote Dan Lewis, “When most people start thinking about the cube, they see nine squares of each colour that can be put in any random place on the cube. But in reality, there are only three types of pieces and they can only be kept in their respective positions. These types are center pieces, edge pieces, and corner pieces.” (emphasis added) Understanding the workings of the Cube is pre-emptory to knowing how to solve it. There are 26 cubies outside of the Rubik’s Cube with an invisible “cubie”, or rather a rotating mechanism, in the middle. There are 3 corner cubies with 3 colours each, 12 edge cubies with 2 colours each and 6 centre cubies of one colour. In the original Rubik’s Cube, blue is opposite to green, red is opposite to orange and yellow is opposite to white. This arrangement remains as you twist the Cube. Do not be confused if your Rubik’s
Cube is of a different face colour arrangement, just note that the colours of the ordered position are fixed by the centre cubie’s colour or its colour determines the colour of that face. When you are clear about this, pick up your Rubik’s Cube and let us start with Rubik’s suggested solution!

There are only 5 move sequences or algorithms you need to learn for this method: the Edge Switcher, the Edge Switcher with Flip, the Switch 3 Corners, the Corner Flipper Right and the Corner Flipper Left.

**Edge Switcher**

Hold the cube like this before performing this sequence. This sequence swaps two edge cubies, but keeps the colours untouched. It forces two corner cubies on the bottom layer to switch as well, but we don't care about them now. The sequence keeps every other cubie in place.

Advance from left to right:

D'FD'F''D'R'D'RDBR'B'

If you want to flip the cubies as well, use the EDGE SWITCHER WITH FLIP sequence.

**Edge Switcher with Flip**

Hold the cube like this before performing the moves. This sequence switches two edge cubies and changes the colour orientation of them, and forces two corner cubies to switch as well, but we don't care about them now. The sequence keeps every other cubie in place.
Advance from left to right:

T"FRF"TFT"RBTB'R"T"

Switch Three Corners

Hold the cube like this before performing this sequence. This sequence switches three corners, but keeps every other cubie untouched.

Advance from left to right:

R'TLT'RTL'T'

Corner Flipper Right

Hold the whole cube like this before performing the sequence. Let the corner cubie you want to make right-coloured be in the front!

Advance from left to right:
LT’L’TL’T’L’R’T’R’R’T’R’T’R

Corner Flipper Left

Hold the whole cube like this before performing the sequence. Let the corner cubie you want to make right-coloured be in the front!

Advance from left to right:

RT’R’T’R’T’L’L’

Step 1

Now the first step of Rubik’s solution is to form a cross on top of the Cube so that the colours of the edge cubies match the colours of the centre cubies. It is usually relatively easy, requiring only 2 or 3 moves. The easiest way is to put the edge cubie to the bottom layer below its place, turning away the middle layer and the layer opposite to the layer where it will fit. Then move the edge cubie to the top, and back the layers you moved away. Then position the top layer again because it is possible it moved away.

Step 2

After you have formed a cross on the top face, place the edge cubies of the middle layer with good colour orientation. Choose either the Edge Switcher or Edge Switcher with Flip sequence, depending on whether you need to change the colour orientation of two neighbouring edge cubies. Refer to the pictures above to compare the colour orientation.

Some other possible scenarios:
1. If the edge cubie of the middle layer is in its correct spot with the wrong colour orientation, move it to the bottom layer with an Edge Switcher, then back with the proper Edge Switcher sequence.

2. If the edge cubie you want to position is not next to its place but 2 steps away on the bottom layer, use the Edge Switcher to move it next to its place. Then you can use the Edge Switcher or Edge Switcher with Flip to put it in the right place. The picture below is turned up to let you see the bottom face. What is simple about these move sequences is that you can just use them over to get to the position and orientation you want.

3. If the edge cubie you want to position is opposite to its location in the bottom layer, then move it to the bottom layer next to its place using the Edge Switcher sequence. Then go to step 1.

4. The last scenario is if the edge cubie is on the other side of the Cube in the middle layer. You just have to use the sequences to move it closer step-by-step to its correct spot, as seen below. Choose the appropriate steps and direction.

At the end of Step 2 your Cube should look like this:
Place the edge cubies of the bottom layer with good colour orientation. Use one of the two Edge Switcher sequences to achieve this. Don’t forget that now you have to position the 4 bottom edge cubies and work on the bottom layer only.

When you are done, your Cube should look like a crusader with crosses on every face. The corner cubies are all that’s left for you to tackle with. Some may be in their correct spots but if they are not, it’s alright. You have other steps to handle them.

![Cube with crosses on faces]

**Step 4**

Now you are placing the corner cubies. The Switch Three Corners sequence would be of help. It is good because it leaves all the other cubies in their positions. Just do not forget to let the same face of the Cube face you in your operations. When you find 2 neighbouring corners you can position, disregarding the colour orientation first, make sure the 3 corner cubies you want to switch are on the top before you start the sequence.

1. If there is only a centre cubie “between” the corner cubie and its right place, perform the Switch Three Corners sequence twice if you want to keep the 4\textsuperscript{th} cubie “behind” the 3 moving cubies during the sequence.

![Cube with 3 corner cubies on top]

2. If the corner cubie is not in the same layer, use the Switch Three Corners sequence twice – first to move the corner to the same layer then perform one or two more sequences to put it in the right spot. Turn your Rubik’s Cube so that the 3 corners for the Switch sequence are on top. The point is to know what sequence to use.

![Cube with 3 corner cubies on top]

Now, your 8 corner cubies should be in their right spots. The colour orientation may or may not be correct.

**Step 5**
The last step is to correct the colours of the corner cubies using either the Corner Flipper Right or the Corner Flipper Left. The Corner Flipper Right sequence rotates one corner cubie clockwise in place and forces the next corner to rotate in the other direction. The Corner Flipper Left sequence rotates 1 corner cubie counter clockwise in place and forces the next corner to rotate in the other direction. You can refer to the earlier pictures for clarity. Let the corner cubie you want to colour-orientate be in the front and on top.

Here advance step-by-step zigzagging all through the corner cubies. Choose the first to correct by chance or start from an already correct corner.

1. If only 1 of the 2 corners rotated with the sequence gets the right colour orientation, turn your Rubik’s Cube so that the wrong-remaining corner is in the front and on top.
2. If both corner cubies get the right colour orientation, use the sequence one after another on the other corner cubies. Select the holding position of the Cube wisely.
3. If 2 opposite corner cubies are with the wrong corners but the other corners of the same layer are right, use the Corner Flipper sequences in one of the wrong and one of the right corner cubies, so you make one corner right and one corner wrong. Use the sequence in the now-spoilt corner and in the previously wrong corner.

When only two corner cubies have the wrong colour-orientation, they will be alright when the right Corner Flipper sequences are used on them. When this is done, you have solved your Cube. Congratulations!

**Now for another method:**

There are generally two main ways of solving the Cube – Layer by Layer or by Corners First. Within each category lies countless different solutions, and there is much debate as to which are the most efficient solutions.

The Layer by Layer method is the method of choice for some of the best Speed Cubers in the world, and one such Cube enthusiast is Miss Jessica Fridrich. A multiple champion in many Speed Cubing competitions around the world, she has come to develop her own Layer by Layer method over the years, and her method has proved to be so effective that it is one of the most commonly adopted methods in the Cubing sphere. Mention the Fridrich method and all Cube Lovers will instantly know what you are talking about!

Here we will not attempt to explain the Fridrich method, but will instead illustrate a simpler layer by layer method by Mr Christophe Goudey.
First Layer

Always start with the same face as it’s easier and helps avoid confusion. Let’s start with the white face as the white facelets are easy to identify and locate. The aim of the first step is to complete the first layer, so that it will look like the diagram below.

To get this first layer, we will do it in two sub-steps:

a) Firstly you do a white cross with the right order so that the side colors match the ones of the central pieces of the second layer:

b) Secondly you complete the layer with the corner-cubes. This step is a little harder than the last one since you have to save the cross. The basic algorithms are provided in case you need help.
c) Now the Cube looks like this:

And the other two sides of the Cube should look like this:

**Second Layer**

d) For the second layer, turn the Cube upside down, like this:

As can be seen from the two diagrams above in step c) and the diagram above from step d), we have one empty corner left that is not filled in. We will proceed to make use of this empty corner to place 3 edge cubes of the second layer.

e) This sounds slightly complicated but do not panic! Here are two very simple and symmetrical movements that will allow you to achieve the desired effect.

![R U' R']

![L' U L']
Put 3 edge cubes of the second layer this way.

f) Now the Cube looks like this:

![Cube Image]

g) Turn the cube upside down again (the white facelets should be form the Up side U now), and place the last corner of the first layer. Do this the same way you placed the first corners---you can refer to steps a) and b) if necessary---but be careful not to unfortunately remove one of the 3 well placed edge cubes of the second layer.

h) To achieve this, you will have to use one of these two algorithms, depending on what your Cube looks like at this current stage:

![Algorithms Image]

- D’ R’ D R D F D’ F’
- D L D’ L’ D’ F’ D F

Presto! You have now completed the first two layers if everything went well! That wasn’t so bad, was it?

**Third Layer**

i) To solve the last layer, turn the Cube upside down once again, with the uncompleted face as the Up side U
j) We are going to make a blue cross, without worrying about the order of the cubes that form the cross. One algorithm and its reverse are necessary:

\[
U F R U R' U' F' \\
F U R U' R' F'
\]

If you have no blue cubes on the top (except the center piece), then you'll have to do firstly one of the algorithms (it doesn't matter the one you choose).

k) Next, we will orientate the cross. The following algorithm has this effect:

The front cube of the cross doesn't move and the other 3 switch round clockwise.

\[
R U'' R' U' R U' R'
\]
If you want the 3 cubes to turn counter-clockwise, apply 2 times the algorithm or apply the reverse algorithm (R U R' U R U'' R').

I) Now, we will place the corners of the Cube.
The purpose of this step is to place each corner-cube in its final place, but without worrying about its orientation for the moment. Thus, for example, the blue-green-red corner-cube has to go in its final place, but the colors of the corner do not necessarily correspond correctly to the color of the face.

L' U R U' L U R' U'

If you want the corners to switch counter-clockwise, apply the algorithm 2 times or apply the reverse algorithm (U R U' L' U R' U L').

Repeat this step as many times as necessary (when you are used to solve the cube you'll see that 2 times is usually sufficient).

m) For our last and final step, we have to orientate the corners such that the colors will correspond to the colors of the faces.
You can achieve this by following the algorithm below. This algorithm is a little long, but don't worry, because if you look at it carefully, you'll notice that you already know the first part (as it is the algorithm of step k)

R U" R' U' R' L' U" L U L' U L
Repeat this step as many times as necessary, and before you know it, you will have solved your very own Rubik’s Cube! Amazing isn’t it!

Now that we have learnt about the standard Rubik’s notation used around the world and solved our very own Cube by the Layer by Layer method, let us take a very brief look at the other solving method---the Corners First method.

The Corners First method is preferred by many renowned Speed Cubers as well, Mr Gaétan Guimond being one of them. He describes his method as one “by which the cube could be solved after only fifty moves with very little calculation”, and he has won numerous competitions around the world using his own method. Essentially, the Corners First method involves fixing your attention only on the corners when you start. The aim is to establish at least 3 out of 4 corners of each face to be of the same color, before proceeding to work on the rest of the Cube. A detailed explanation of the Corners First method will be shown in the next issue of our magazine, so be sure not to miss it!
Nifty Patterns

If solving the Rubik’s Cube isn’t really your cup of tea and only serves to leave you with a great headache, you can try to make fun and interesting patterns with your Cube instead! Our **Nifty Patterns** section shows you diagrams of the patterns you can attempt with your Cube in the comfort of your office or own home, and all diagrams have the corresponding algorithm below it for you to follow.

All patterns assume you start with a fully solved cube.

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**Legend**

- **R** = Clockwise turn of right face
- **R’** = Counterclockwise turn of right face
- **R”** = Half turn of right face

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Did you know that...

- The Cube has 43,252,003,274,489,856 different possible configurations. One, and only one, of these possibilities present the 'solved' Cube, having a single colour on each of its 6 sides. If you allow one second for each turn, it would take you 1400 million million years to go through ALL the possible configurations. As a comparison, the whole universe is only 14 thousand million years old.

- The least number of moves required in unscrambling the Cube from the worst disorder, the shortest route, if often called God's Algorithm. Morwen Thistlethwaite, using computers at the Polytechnic of the South Bank in London, calculated it to be 52 moves. This number was subsequently reduced to 50 and it is thought that this magic minimum number may turn out to be somewhere in the low twenties.

- The World RUBIK Cube championship was held in Budapest on June 5, 1982. Nineteen National Champions took part. Minh Thai, the US Champion, won by solving the Cube in a time of 22.95 seconds. The world record, in competitive conditions was subsequently lowered a number of times and now stands at 16.5 seconds.

- 'RUBIK Cube' has become part and parcel of the English language and attained official status by having its own entry in the Oxford English Dictionary.

- By 1982, sales rose to such unprecedented levels that in the West, according to some calculations, one in every three households possessed at least one RUBIK's Cube.

- The compelling quality of the Cube was such that two brand new medical conditions became rife among the more serious addicts. They are known as the Cubist's thumb and Rubik's wrist.
• Andras Mezey, one of the leading Hungarian authors of this generation, wrote a highly successful musical play entirely devoted to the Cube. The play, incidentally critical of the Communist regime, ran for three consecutive seasons in a large Budapest theatre.

• The Cube, through its international renown and export achievement, was one of the contributory factors in the reform and liberalisation of the Hungarian economy between 1981 and 1985 which led finally to the transition of the system from Communism to Capitalism.

• The Massachusetts Institute of Technology established a regular series of 'Cube-ins' for its staff and students to explore various mathematical ramifications created by RUBIK's Cube.

• Frau Schmidt of Dusseldorf in Germany, sued her husband for divorce in 1981 citing the Cube as correspondent. She complained: 'Gundar no longer speaks to me and when he comes to bed he is too exhausted from playing with his Cube to even give me a cuddle'.

• A football game in Connecticut was delayed when one player, Bob Blake, failed to take the field. He was found in the locker room playing with the Cube.

• At the Edinburgh Conference of European leads in 1992, John Major, the British Premier, used RUBIK’s Cube to explain to his TV audience the virtually insoluble complexities of the Maastricht Treaty.

• 'Cubaholics Anonymous' a voluntary organisation to help Cube addicts kick the habit was founded in 1980 by Augustus Judd, a self-confessed Cubomaniac.

• Apart from the hundreds of Cubes with different surface decoration, over 60 self-contained, 3D puzzles with various geometries and moving parts, came to market between 1981 and 1984. ALL of them derived fundamentally from the original RUBIK’s Cube. No other single toy had anywhere near the kind of impact on the Toy Industry, ever.
Incredible mosaics made up of Rubik’s Cubes

So... what's the big deal about this cube, really???

1) The parts of the cube stay together— in contrast to many other moving-piece puzzles.

2) Several pieces move at once— again in contrast to all other moving-piece puzzles that was known of.
3) The pieces have orientation. By this, we mean that a piece can return to its original position but in a distinguishable orientation from its original one. Most puzzles with this property are assembly puzzles, which are very different in nature from the cube.

4) The three-dimensionality of the cube, as such moving pieces puzzles are very rare.

5) The cubicality of the cube. The cube is the most basic three-dimensional shape. On a sphere, it is difficult to make a 90° turn as there are no edges to align visually or tactually.

6) The colours of the cube are striking. If three primary colours were opposite their respective complementary colours, it would be more striking, but Rubik found that a white face was essential to brighten up the appearance of the cube. The colour pattern was then standardized so that opposite faces differ by the colours: white-yellow, red-orange and blue-green.

7) The complexity of the cube, it is unprecedented for such a simple-looking to reproduce such complexity and for such a complex puzzle to be so popular. The complexity of the cube is so great that everyone will find a different solution.

8) The educational value of the cube, it has already greatly increased the three-dimensional abilities of students of all ages from 6 years old.
Other Rubik Toys

Megaminx

Megaminx in the shape of a dodecahedron! It has a similar working mechanism to that of Rubik’s Cube. But instead of having 6 faces of a square, it has 12 faces of a pentagon, 12 sides which rotate. There are two types: The Hungarian SuperNova & The Megaminx. Edge pieces are a bit thicker on the Megaminx than…. the… SuperNova.

Cube 21

Cube 21 is also known as Square 1. This cube is not solely made up of the elements of cubes alone but with other irregular shapes as well. It is in a mixed up state and your task will be to put it back to a Cube shape. This task could have been more difficult than that of solving the Rubik’s Cube!
Rubik’s Snake often comes in a ‘ball’ shape. Thus, we have to unwrap it into its free form shape, probably into a line, before playing with it. This is defined as the base position (reference position). The toy itself will have 24 triangles joined together. The end triangles are of different colours from each other, and are only connected on one edge. All other triangles will be connected on 2 edges. Rubik’s Snake makes a wonderful puzzle as well as an educational toy!

More Shapes
**Pyraminx**

The standard Pyraminx is a regular tetrahedron with each triangular face divided into 9 identical triangles, three to a side. One moves it by rotating a sub-tetrahedron around a vertex. This sub-tetrahedron can either be just a tip or a larger tetrahedron (two triangles to a side). Each face has one colour. The edge pieces have two colours. The tips and the adjacent vertex pieces have three colours each. Uwe Mèffert invented the Pyraminx in about 1971.

The Pyraminx with blue pieces is a little smaller.

**Pyramorphix**

This puzzle is a small regular tetrahedron where each triangular face is divided into 4 smaller triangles. It is much similar to the 2x2x2 Rubik's Cube, where each square face is divided in 4 squares. Moreover, the pieces forming one tetrad are flat and have one colour. The other tetrads form the vertices of the tetrahedron. Each tetrad has a colour each. This puzzle does not maintain the same shape, making it somewhat confusing to solve.

Another way to see this puzzle is as a small octahedron, on which the four faces meeting at a vertex can rotate about that vertex. Four of the faces of the octahedron have tips stuck on them; the other faces are just flat.

**Magical Octagonal Prism**

This variation on the Rubik's cube is called the Magic Octagonal Prism, or just The Barrel/ The Octagon. It is exactly the same except that the four vertical edges of the cube are truncated. The corner pieces of original cube now have only 2 colours (instead of 3). The four edge pieces in the middle layer have only one colour.
And some other noteworthy toys...

Rubik’s Triamid

Rubik’s Darth Maul
Think you know the Rubik’s Cube inside out? Take this quiz to see how much you really know about this wonder cube!

1) How many layers does the Rubik’s Revenge have?
   a) 2  
   b) 3  
   c) 4  
   d) 5

2) How many loose pieces are there when you dismantle a 3x3x3 cube completely?
   a) 20  
   b) 21  
   c) 25  
   d) 26

3) When was the Rubik’s Cube first known internationally?
   a) 1974  
   b) 1979  
   c) 1980  
   d) 1983
4) How many possible combinations are there in the Rubik’s Cube?
   a) 4200
   b) 45,000
   c) 4 million
   d) 43 quintillion

5) Which colour did Rubik not consider when he first “clothed” the Cube?
   a) Blue
   b) White
   c) Pink
   d) Orange

6) What is the name of the least number of moves to unscramble a Cube in the worst disorder?
   a) God’s Algorithm
   b) Devil’s Algorithm
   c) Genius Algorithm
   d) Rubik’s Algorithm

7) How many cubies does a Professor’s Cube have?
   a) 100
   b) 98
   c) 120
   d) 86

8) What is another name for Cube 21?
a)  Rubik’s Square
b)  Century Cube
c)  Square 21
d)  Square 1

9)  Where will the next World Rubik’s “Games” Championships be held?
a)  Hungary
b)  Japan
c)  Canada
d)  Australia

10) What is the present (2003) world record for the quickest time taken to solve the Rubik’s Cube?
a)  17.3 sec
b)  16.5 sec
c)  22.95 sec
d)  20.45 sec

Ready to check your answers?
We would like to acknowledge certain indispensable sources that made our magazine a success. We extend our special thanks to:

**Websites**

http://www.24hours7days.com/Puzzles/Classic_Puzzles.html

http://www.chrisandkori.com/megaminx.htm

http://www.cubeland.fr.st/

http://www.eightyeightynine.com/games/rubiks-cube.html

http://www.funtrivia.com/dir/25.html

http://www.geocities.com/jaapsch/puzzles/

http://holly.wordthunder.com/

http://home.t-online.de/home/thlet.wolter/trubiks_en.htm

http://inventors.about.com/library/weekly/aa040497.htm

http://www.klubvh.hu/rubiksite/demo/cubefacts.html

http://www.kurilka.com/rubik2.html

http://www.puzzle-shop.de/start-shop.html

http://www.puzzlesolver.com/


http://www.speedcubing.com/chris

http://www.theory.csc.uvic.ca/~cos/inf/misc/PentInfo.html

http://webplaza.pt.lu/geohelm/myweb/cubeold.htm


**Book**
