

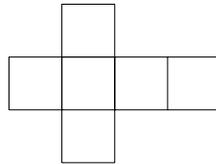
Blindfold Cubing

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The following is an introduction to blindfold cubing. It does not always show the most efficient methods. It will be built up in chapters - as of the present it is somewhat incomplete.

1 1x1x1 Cubes



1.1 Memorizing The Cube

There really is nothing to do.

1.2 Donning The Blindfold

Don the blindfold.

1.3 Permuting And Orienting All The Pieces In One Go!

There really is nothing to do.

1.4 Putting The Cube Down

Say "bad cube" or prepare a lethal injection and give it to the cube. No that's all very cruel. Seriously, just put the cube down (place it down).

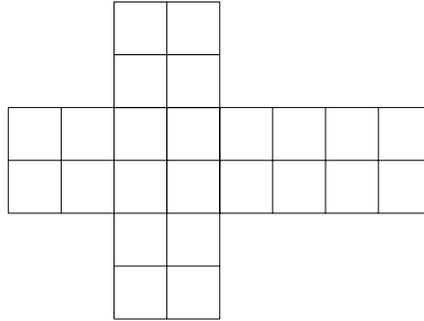
1.5 Removing The Blindfold

Remove the blindfold.

Unless you are really incompetent the cube should be solved.

Stop being silly and progress to:

2 2x2x2 Cubes



Solving the 2x2x2 cube blindfolded is important in solving bigger cubes blindfolded. If you can do this then it will help in solving the corners of bigger cubes. If you can't then you haven't much hope on bigger cubes.

2.1 Memorizing The Cube

With the 2x2x2 having no fixed centres we are free to make sure at least one corner is solved before we even start. To begin the memorization place the cube so that the DBL corner is in the correct place and is correctly oriented.

On my cube I use the White side as Up face, the Green side as Front face and the other faces are Down - Blue, Back - Yellow, Right - Red, Left - Orange. So for me, that means positioning the cube so that the Blue-Yellow-Orange piece is in the DBL position with Blue on the D face.

Now we are ready to start memorizing the cube:

each corner has a number associated to it as follows: start with 1, add 1 if the corner has the Left (Orange) colour on it, 2 if it has the Back (Yellow) colour on it and 4 if it has the Down (Blue) colour on it.

Thus the Up-Back-Left (White-Yellow-Orange) piece has the number $1+1+2=4$ associated to it.

The Down-Front-Right (Blue-Green-Red) piece has the number $1+4=5$ associated to it.

Memorize the number of each cube in turn in the following order:

- the corner in the UFR position (this may not be the UFR corner)
- the corner in the UFL position
- the corner in the UBR position
- the corner in the UBL position
- the corner in the DFR position
- the corner in the DFL position

- the corner in the DBR position

You don't need to memorize the corner in the DBL position as it is the DBL piece. Technically, you don't need to memorize the corner in the DBR position either as, when you get to that stage, it is the only possible piece left. Having said that, in bigger cubes we will memorize all 8 pieces. (Although we need only really do 7.)

This gives a sequence of 7 digits from 1-7 in some order, which we call the corner permutation.

For instance, if it is 2 5 7 1 4 6 3 then

- the UFL corner is in the UFR position,
- the DFR corner is in the UFL position,
- the DBR corner is in the UBR position,
- the UFR corner is in the UBL position,
- the UBL corner is in the DFR position,
- the DFL corner is in the DFL position,
- the UBR corner is in the DBR position,
- the DBL corner is in the DBL position.

In the solved cube the corner permutation will be 1 2 3 4 5 6 7 (8).

We also need to remember the orientation of each corner: the orientation of a corner will be a number 0, 1 or 2 defined as the number of times you would have to physically twist the corner clockwise to get the U (or D) part of the corner into the U (or D) face.

The following table shows the orientation of corners:

Position	Face In Which U or D part of corner lies	Orientation
UFR	U	0
UFR	F	1
UFR	R	2
UFL	U	0
UFL	L	1
UFL	F	2
UBR	U	0
UBR	R	1
UBR	B	2
UBL	U	0
UBL	B	1
UBL	L	2
DFR	D	0
DFR	R	1
DFR	F	2
DFL	D	0
DFL	F	1
DFL	L	2
DBR	D	0
DBR	B	1
DBR	R	2
DBL	D	0
DBL	L	1
DBL	B	2

In our setup (for the 2x2x2), the DBL corner will automatically have orientation 0, but this will not always be the case for larger cubes.

Memorize the orientations of the cube in the same order as you memorized the positions.

This gives a sequence of 8 numbers, each 0, 1 or 2, the last of which will be 0, so you don't need to remember it.

The sum of the orientations over the various corners will be divisible by 3. (*) Thus 0 1 2 1 1 1 0 0 is a valid orientation since $0+1+2+1+1+1+0+0=6$ is divisible by 3.

On the other hand, 0 1 1 1 1 1 0 0 is not a valid orientation since $0+1+1+1+1+1+0+0=5$ is not divisible by 3. In this case you can't solve your cube without taking it apart.

In the solved cube the sequence will be 0 0 0 0 0 0 0 (0).

The fact (*) allows us to only memorize the first 6 numbers if we want (since the last one is 0, so we could work out the 7th).

So now you have two sequences of numbers remembered. The first is the permutation sequence and has length 8, although you can get away with 7 or even 6. The second is the orientation sequence and also has length 8, but again you can get away with 7 or even 6.

Now we are ready to don the blindfold. (N.B. the sequences above have to be

worked out visually - nothing is to be written down in blindfold cubing, nor may moves be made to the cube before donning the blindfold.)

2.2 Donning The Blindfold

Don the blindfold.

2.3 Orienting The Corners

This stage is the same for cubes of any size and it should be done first. The objective here is to find pairs of corners whose orientations are 1 and 2 or to find triplets of corners whose orientations are all 1 or are all 2. The stage is ended when every corner has orientation 0.

Supposing we have a corner that needs orienting then there will be at least 2 (by fact (*)). There are two possible situations: there is at least one corner of orientation 1 and at least one corner of orientation 2 or not.

In the first case, we will orient a corner of orientation 1 and a corner of orientation 2.

To do this we will require the corners to be adjacent. If they are not, then we can do a move M to ensure they are.

For instance, if the corners are in positions UBR and DFL then the move $M=UD$ will move them to positions UFR and DFR respectively.

Orient the entire cube so that the piece with orientation 2 is in the UFR position and the piece with orientation 1 is in the DFR position (†) (and remember how you did that - one way it to keep track of the DBL piece - position and orientation) and do the move $R^{-1}D^{-1}LDRD^{-1}L^{-1}D UL^{-1}UR^2U^{-1}LUR^2U^2$.

Then undo the orientation of the entire cube (i.e. undo what you did in (†)) and do M^{-1} (in the example above $D^{-1}U^{-1}$).

This will orient the two corners.

Repeating this we can get to the stage where either all the corners are correctly oriented or else all the incorrectly oriented corners have the same orientation (either 1 or 2). In the latter case there will either be 3 or 6 such corners by (*).

As before use a move N to get two of these corners into the UFR and DFR positions. Use the main move and then perform N^{-1} . If the corners had orientation 2, the main move will have correctly oriented the corner that N moved to the UFR position and the the corner moved to the DFR position by N will now have orientation 1.

If the corners had orientation 1, the main move will have correctly oriented the corner that N moved to the DFR position and the the corner moved to the UFR position by N will now have orientation 2.

Then you will have a corner of orientation 1 and a corner of orientation 2 which you can fix by the method described above. This process will need to be done twice if you had 6 corners all oriented 1 or all oriented 2.

At this point you should be done orienting corners.

From now on we use moves that do not alter the orientation so you can throw away that sequence and concentrate on the permutation.

2.4 Permuting the corners

Throughout it is important to keep updating the mental picture of the permutation.

Corner 8 (DBL corner) is already in position. Consider the D face. If corner 7 (the DBR corner) is in the D face we may correctly position it straight away using a move of the form P1 or P2 from

http://www.speedcubing.com/final_layer_permutation.html

which is a 3 cycle of edges (look at the diagram to see what this means). The move would be $R^{-1}BR^{-1}F^2RB^{-1}RF^2R^2$ if corner 7 was in position 5 (the DFR position) - it would be $FL^{-1}FR^2F^{-1}LFR^2F^2$ if the corner 7 was in position 6 (the DFL position). It is important to keep track of where the other 2 corners that are moved go (by updating you mental permutation).

Instead of memorizing these as separate moves, it is better to get the idea in principle and work spontaneously. (I would probably rotate the entire cube so that the D face was U and do the move in the (new) U face and then rotate the entire cube back again.) If corner 7 is in the U face then rotate the U face (\ddagger) so that it is in the UBL position and use $R^2(R^{-1}FR^{-1}B^2RF^{-1}R^{-1}B^2R^2)R^2$ and then undo the rotating of the U face (i.e. undo \ddagger). This will position corner 7. (Note the 3 cycling should be done only in the U and D faces: otherwise you will have the additional complexity of corners becoming disoriented and you will have to reorient them.)

Now, if corner 6 is in the D face it is either in the correct position or not. If it is not it is in position 5.

The move $F^2(RB^{-1}RF^2R^{-1}BRF^2R^2)F^2$ will correctly position corner 6 in the case it was in position 5.

On the other hand, if corner 6 is in the U face then rotate the U face until it is in the UBR position, using U^i for some i (possibly it is already there and there is nothing to do).

Then use $F^2(R^{-1}FR^{-1}B^2RF^{-1}RB^2R^2)F^2$ followed by undoing U^i (i.e. doing U^{-i} to correctly position corner 6).

If corner 5 is in the D face it is correctly positioned. If not, it is in the U face. Rotate the U face to get it in the UBL position, using some move U^j . Then $F^2(LF^{-1}LB^2L^{-1}FLB^2L^2)F^2$ followed by U^{-j} will position corner 5 correctly.

So now all the corners 1-4 are in the U face. To get corner 1 into the correct place, if it isn't already, if it is in position 2 use P2, if it is in position 3 use P1 and if it is in position 4 use $(P2)^{-1}$.

To get corner 2 into the correct place, if it isn't already, if it is in position 3 use $(P1)^{-1}$ and if it is in position 4 use P2.

Now if corner 3 is in the correct position you can put the cube down and remove the blindfold. If you didn't mess up and the instructions are clear you will have solved the 2x2x2. If corner 3 is in position 4 there are a couple of strategies: firstly use $U(P1)^{-1}$ (or $U^{-1}P1$ - it is a matter of taste) or use move P10. The advantage of P10 is that in bigger cubes you will have moved only two edges (each consisting of n-2 edge pieces) whereas with the other you will have moved 4 of them (making updating the mental edge permutation map harder) - either

way you will not have spoiled the orientations.

2.5 Putting The Cube Down

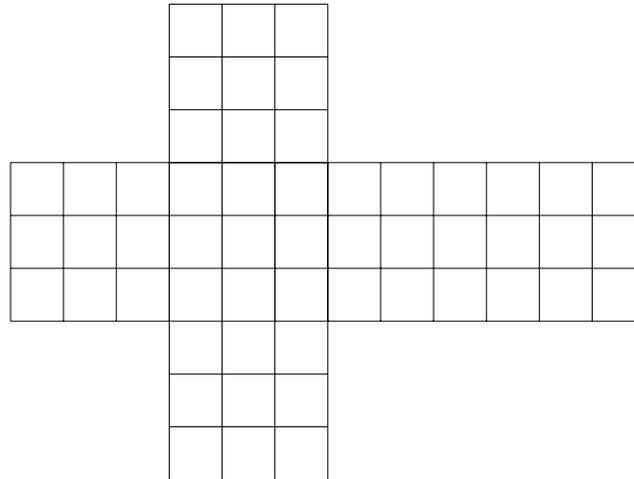
Put the cube down. (I always put it down (for any size cube) with the face I was working with as U face as U face (on top) and the face I was using as F face towards me.)

2.6 Removing The Blindfold

Remove the blindfold. If you didn't mess up and the instructions are clear you will have solved the 2x2x2.

If you can consistently solve the 2x2x2 blindfolded you are ready for the next stage, the 3x3x3.

3 3x3x3 Cubes



The 3x3x3 cube is a little more complicated than the 2x2x2 cube.

3.1 Memorizing The Cube

We can not assume that a corner has already been solved as was the case with the 2x2x2 cube because there are fixed centres on the 3x3x3 cube. To make memorization easier and faster I recommend that you always start off with a particular face as U face and a particular face as F face (unless the cube looks particularly easy from another point of view - e.g. corners already oriented et cetera) - I use White as Up face and Green as F face.

I already discussed memorizing corners for the 2x2x2 - the same principles apply here except you have to remember at least 7 corners as the last one is no longer

fixed. I just remember the whole 8 of them as it isn't too much extra work and provides extra security.

Therefore, I will begin here by talking about the edges. First the numbering of the edges. The edges are numbered 1-12 by the following scheme:

the edges belonging to the U face are numbered 1-4 according to UF=1, UB=2, UR=3, UL=4;

the edges belonging to the D face are numbered 5-8 according to DF=5, DB=6, DR=7, DL=8;

the other edges are labelled 9-12 according to FR=9, FL=10, BR=11, BL=12.

If you have read the section on 2x2x cubing you will see that I have labelled them according to priority. Thus the U,D faces have high priority (and within these I make U have higher priority than D), the F,B faces have medium priority (and within these I make F have higher priority than B) and the R,L edges have low priority (and within these I make R have higher priority than L). Then the edges are ordered according to priority with a lexicographic order (given 2 edges GH and IJ, GH comes before IJ if G has higher priority than I or if G=I but H has higher priority than J - so UL comes before DF because U has higher priority than D (irrespective of F having higher priority than L) and UR comes before UL because R has higher priority than L).

The edges should be memorized in the order that would give 1-12 in the solved cube.

So the edge permutation 2 11 7 8 12 10 5 1 9 6 4 3 has the UB edge (edge 2) in the UF position (position 1) and the BR edge (edge 11) in the UB position (position 2) and the DF edge (edge 5) in the DL position (position 8) for example.

Technically, you only need to remember the position of the first 11 edges (as the last one is then automatically predetermined). In fact, it is possible to remember only the first 10 edges (or the first 11 edges and the first 6 corners) because the permutations must both be odd or both be even (you'll be OK if the cube can be solved - i.e. is put together correctly - as the other 2 can then be worked out). If that doesn't make any sense don't worry, it's not essential and in fact for peace of mind it's better to remember all 12 anyway. In any event you have to remember at least the first 7 orientations (corners) and 11 orientations (edges).

So much for position, now we come to orientation.

An edge has distinct colours and one of these is higher priority than the other (even using the more primitive priority scheme of high, medium, low - that's because the priorities are chosen so that the two colours of high priority are on opposite faces (so edges and corners can't have 2 colours of high priority) and similarly for medium priority and for low priority).

Given an edge in a particular position the edge lies in 2 faces (for instance if the UF edge is in the BR position it is lying in the B face and the R face). If the higher priority colour of the 2 edge colours is in the higher priority colour of the 2 face colours (which we take to be the colour of the centre square) then we say that the edge has orientation 1 (is incorrectly oriented) otherwise it has orientation 0 (is correctly oriented). Note that in the solved cube the colour of an edge matches the colour of the face in which it lies so that higher priority

matches higher priority and each edge is correctly oriented.

In the parenthetical example above the UF edge is correctly oriented if the U part of the edge is in the B face (as U has higher priority than F and B has higher priority than R) and is incorrectly oriented otherwise.

The total number of incorrectly oriented edges is always even (for a cube that can be solved) so if it isn't like that then the cube can't be solved.

Memorize the orientation of the edges in the same order as the position of the edges. Thus, if you have orientation 1 0 0 1 1 1 0 1 0 1 0 0 then the edges in positions 1,4,5,6,8 and 10 are incorrectly oriented and the edges in position 2,3,7,9,11 and 12 are correctly oriented (not that the UF, UL, DF, DB, DL and FL edges are incorrectly oriented et cetera although that may also be the case). The orientation 1 0 0 1 0 1 0 0 1 1 1 1 doesn't correspond to the orientation of a cube that can be solved as 7 edges need orienting and 7 is not even - that is 7 isn't divisible by 2.

(Aside: a 3x3x3 cube can be solved if and only if the following conditions are satisfied

- The stickers are on correctly (so that if you took it apart it would be possible to assemble into a solved cube).
- The sum of the corner orientations is divisible by 3.
- The sum of the edge orientations is divisible by 2.
- The corner and the edge permutations are either both even or both odd. (A little more technical - if you don't know what this means don't worry, you won't be able to do the neat trick but at least half of the time you should be OK.)

(A 2x2x2 cube is solvable if and only if the first 2 conditions here are met.)

Thus it is possible to determine just by looking at the cube whether it can be solved and, if not, what needs to be done to make it capable of being solved. Each step is fairly easy to verify (except the last).

As a smugness bonus you can take on cubes that can't be solved blindfolded, get as far as possible (up to one edge badly oriented, up to one corner badly oriented and up to 2 corners needing swapping, which you can assume to involve only the UFR and UFL corners and the UF edge) then if necessary take out the UF edge and do the necessary adjustments to each piece and stick it back in. You need to be careful to get the edge back in the correct way but if someone is trying to set you up it should put egg on their faces.

Aside 2: If you are curious, this is how to tell if a permutation is odd or even. I'll just give an example and hope the general technique is clear. It really doesn't matter about this for blindfold cubing.

Say given a permutation 2 11 7 8 12 10 5 1 9 6 4 3 as above.

Start off with 1 and see what lies in position 1, in this case 2. Then go to that position (in this case position 2) and see what lies there, in this case 11. Go to that position and see what lies there - in this case 4. Keep going until you get to 1. This gives what is known as a cycle - in this case we'd write (2 11 4 8 1),

finishing at 8 because 1 is in position 8. Next go to the first unused number on the list (if any) and make a cycle from that. In the present case it is 7. 5 lies in position 7, 12 lies in position 5, 3 lies in position 12 and 7 lies in position 3. We get the cycle (7 5 12 3).

The next unused number on the list is 10 and we get a cycle (10 6). Finally we get a cycle (9).

The entire permutation has cycle decomposition (2 11 4 8 1)(7 5 12 3)(10 6)(9). The order of the cycles is not important, we could equally well write (10 6)(2 11 4 8 1)(9)(7 5 12 3). Also in a given cycle it doesn't matter where we start so (7 5 12 3) is the same cycle as (5 12 3 7), as (12 3 7 5) and as (3 7 5 12), but not as (5 7 3 12).

A cycle is a transposition if it has length 2.

Some cycles have even length and some have odd length. A cycle is odd if it has even length. (This is because such a cycle can be written as a product of an odd number of transpositions in the symmetric group.)

The permutation is even if it has an odd number of odd cycles - otherwise it is even. Thus 2 11 7 8 12 10 5 1 9 6 4 3 is an even permutation since it has 2 odd cycles, (10 6) and (7 5 12 3).

If a cube can be solved then the corner and edge permutations must either both be odd or both be even. (If you are really up for it, their product in the symmetric group S_{12} has to be even.)

Anyway, enough of the asides - they aren't necessary for blindfold cubing.

Once you have memorized the corner and edge permutations (positions) and orientations you are ready to don the blindfold.

I recommend memorizing them in the following order - edges first then corners - end with the corner orientation. The exact order of memorizing the edges (orientation then permutation or permutation then orientation) isn't too crucial.

The hardest to remember is either the corner orientation or the edge permutation.

You should also try to keep in mind pairs of incorrectly oriented edges that you might want to flip together. If you do this you may not have to remember a sequence for the edge orientation - just which pairs to flip.

3.2 Donning The Blindfold

Don the blindfold.

3.3 Orienting The Corners

The first thing to do is to orient the corners. I described this in the 2x2x2 section and it is exactly the same. Those moves will not only preserve the corner permutation but also the edge permutation and edge orientation.

3.4 Orienting The Edges

After this you should usually orient the edges (you could permute the corners, but in the event that you are left with 2 to permute, you will either have to leave them until later or switch some edges and we really want to orient the edges before permuting any of them). If more than 6 edges are to be oriented, a different strategy is to unorient the correct edges and then orient them all at the end.

To do this, I use 2 basic moves. You could use more, but the fewer algorithms the better for blindfold cubing (it is harder to get confused that way).

The two moves are:

$$LsFRsU^2LsFRs B^2U^{-1}RsB^2LsU^{-1}B^2$$

which flips the UB and UL edges (the first part does the flipping and the second part corrects the permutation) and

$$FsUF^{-1}U^{-1}Fs^{-1}LFL^{-1} F^2ULsF^2RsUF^2$$

which flips the UL and UR edges (the first part does the flipping and the second part corrects the permutation).

Note that the correcting steps are quite similar (in fact, they both permute 3 edges - the first does $UR \rightarrow UB \rightarrow UL \rightarrow UR$ and the second $UR \rightarrow UF \rightarrow UL \rightarrow UR$). In fact, you can get away with only using the first of these (as the second can be done using the first followed by U^{-1} then the first then U). I only used the first when solving the Revenge blindfolded.

Of course, you may have to temporarily use different faces as U face, F face et cetera to bring the pieces into the correct places (UL and UB or UL and UR) - if you do, remember what you did so you can undo it afterwards. Also, you may need to use a couple of auxillary moves to get things in the right place. Thus, if you want to flip the edges in the UF and UL positions either rotate the whole cube so that they are in the UL and UB positions do the first move and then rotate the cube back or do $U(\text{the first move})U^{-1}$. If you want to flip edges DF and UR, then do $F^2U^2(\text{the first move})U^2F^2$ et cetera.

After having oriented the corners and edges it's time to permute. If you permute the corners first it is quicker (there are less of them) so you can get onto the edge permutations quite soon. If you do the edge permutations first you have longer to wait to get to the last part of the solution but less to remember when you get there.

Assuming you remembered them well, you might as well permute the corners first (as the edges should be fixed in your mind and you get there quickly).

3.5 Permuting The Corners

Permute as in the 2x2x2 case (you first have to get corner 8 in position if it isn't using similar methods). If you have only 2 to swap at the end, use the move P10

which will change the first two edges in your mental permutation, but preserve the orientation so 11 2 7 8 12 10 5 1 9 6 4 3 would become 2 11 7 8 12 10 5 1 9 6 4 3 for example. The edge permutation couldn't have been 2 11 7 8 12 10 5 1 9 6 4 3 at the outset if you need to swap 2 corners at the end - unless the cube can't be solved).

The technique I give in the 2x2x2 case is really not too advanced. It certainly isn't essential to permute the corners in the way I suggest (8 then 7 then 6 et cetera) and it isn't efficient but is easy and you can lop off the end of the permutation you have to remember at each stage. In general, I would not be using this technique in the exact way I describe.

Remember if you do use this technique, get corner 8 into position first! You didn't have to worry about it for 2x2x2 but you do for 3x3x3.

3.6 Permuting The Edges

Lastly we come to permuting the edges. The basic move is the 3-cycle

$$R^2UFsR^2BsUR^2$$

which permutes 3 edges ($UF \rightarrow UB \rightarrow UR \rightarrow UF$) without altering orientations. If you use U^{-1} in place of U (in both places) you get the inverse permutation ($UF \rightarrow UR \rightarrow UB \rightarrow UF$).

Similarly you can permute on the other side (but if you want to avoid to you could use U^2 (the move) U^2) and other such things.

You can apply this move in 8 ways on the U face (the move and its inverse and you can use U^j (the move or its inverse) U^{-j} for $j=-1,2$ or 1 for the other 6.

You can also do similar moves in the D face, R face or L face. Don't do these moves in the F or B face as they will change the orientation of two of the edges. You could, but you'd have to be careful to reorient the edges. Remember to keep updating your mental image of the edge permutation at each step.

There are a number of ways to proceed. One way is to get the edge of the middle layer in first. You can get them from the U or D layer by using 3-cycles in the L or R face as appropriate.

If they are already in the middle layer but incorrectly positioned you may still be able to use such a move. Another crucial move is $U^2R^2U^2R^2U^2R^2$ which switches the UF edge with the UB edge and the FR edge with the BR edge. This move does not alter orientations and any variant may be safely used, e.g. $U^2F^2U^2F^2U^2FR^2$.

When you're done with the edges of the middle layer you may have to move edges between U and D faces.

The move $Rs^2F^2Rs^2B^2$ switches the UF edge with the DF edge and the UB edge with the DB edge (and preserves orientations). By doing this (possibly preceded by a 3-cycle in the U and or D faces) you can bring 2 U edges from the D face to the up face in exchange for 2 D faces from the U face to the D face (unless you have less than 2 D edges in the U face).

If you have exactly one D edge in the U face then bring another one up first (you can do this as follows: say the D edge is in the UF position for example - if the U edge in the D face is not in the DR position put it there by rotating the D face then use $B^2R^2B^2R^2B^2R^2$ and then undo the rotating of the D face. Remember where everything went!

Then you'll have 2 D edges in the U face in the UB and UF positions and you can use $Rs^2F^2Rs^2B^2$ to get all the U edges in the U position.

Use 3-cycles in the U face to get the DR and DL edges (edges 7 and 8) into the correct positions.

If edge 5 is not in the correct position you need to switch edges 5 and 6, so use $Rs^2U^2Rs^2D^2$. (This will also switch the edges in positions 1 and 2).

Use 3-cycles to position the U edges (you can do this in at worst 2 steps; get any edge into position with the first 3 cycle and then, if you need to use a 3-cycle to get any other edge in position - if your cube can be solved they will now all be in position, unless you messed up somewhere).

3.7 Putting The Cube Down

Put the cube down.

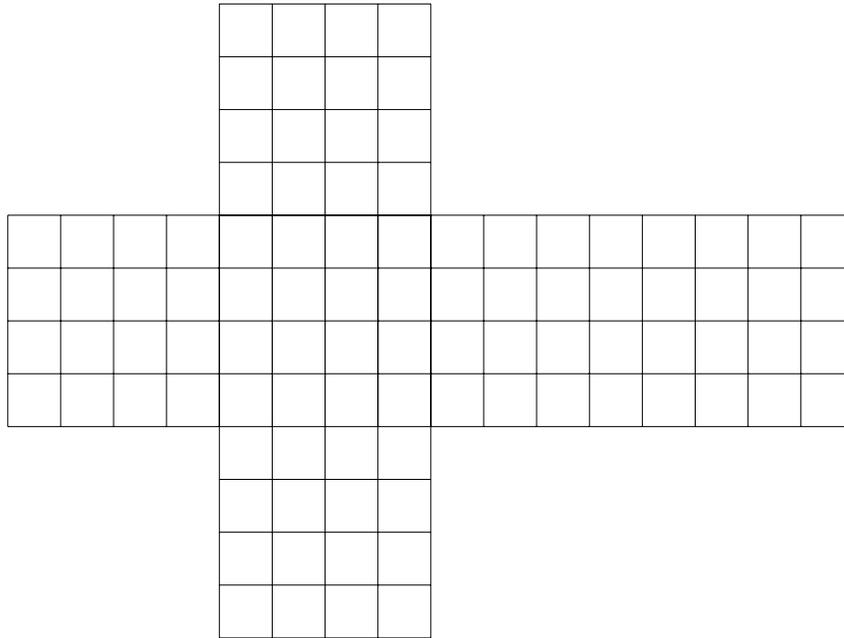
3.8 Removing The Blindfold

Remove the blindfold.

Your cube should now be solved, if you didn't mess up.

When you can consistently do the 3x3x3 cube you will be ready to start the Revenge. (NB It gets a lot harder now.)

3.9 4x4x4 Cubes



Let's just dive straight in.

3.10 Memorizing The Cube

Although we have the option (as there are no fixed centres) of having one corner correctly positioned and oriented at the outset, we do not do that.

Note that there are 6 faces but only 4 centre squares per face. Therefore at least 2 faces will have no U centre squares in them. Usually, we would choose one of these as D face and then try to maximize the number of U centre squares in the U face (which may be none if 4 faces in a ring each have one U centre square). In the event that 2 opposite faces have U centre squares and none of the others do, if possible choose the one with more U centre squares as U face or, if each has 2 the one with least D centre squares as U face. If each has 2 U centre squares and the same number (0, 1 or 2) of D centre squares then choose the face with more U corners as U face. If each has 2 U corners just choose arbitrarily.

The corners should be memorized just as for the 2x2x2 or 3x3x3 cube (both permutation and orientation) and you'll need to memorize at least 7 of them, but you might as well memorize all 8. (You should memorize these last, I mention it now for continuity. The memorization sequence should be edges, centres, corner permutation, corner orientation.)

The edges are labelled A-X (one symbol each, easier than 1-24 - also harder to confuse with other permutations) and according to the same order as for the 3x3x3 cube. Each edge has 3 identifying letters. Thus the UF edge comprises

the UFR edge (edge A) and the UFL edge (edge B). The edges C-Z are (in order) UBR, UBL, URF, URB, ULF, ULB, DFR, DFL, DBR, DBL, DRF, DRB, DLF, DLB, FRU, FRD, FLU, FLD, BRU, BRD, BLU, BLD. (So first by edge (the same order as the 3x3x3 edges) and within edge by higher priority face.

Try to memorize in pairs or in fours.

This is all you need to do to memorize the edges. There is no orientation to remember. If a piece looks like it is badly oriented (in what should be the correct place) then it is actually not the edge you are looking for. (In cubes of any size the only edges you need to attach an orientation to are in the odd size cubes and then only the centre edges.)

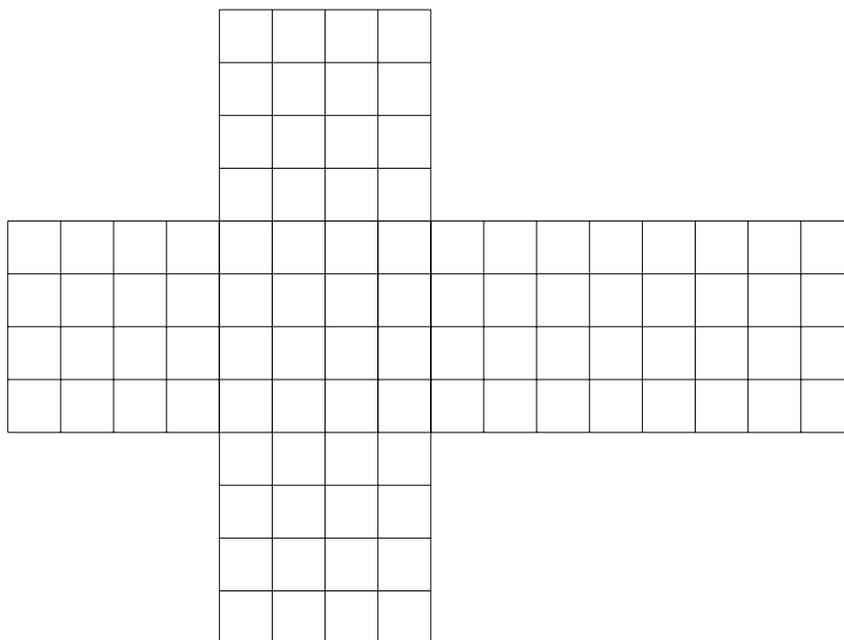
Of course, you need to be able to distinguish between edges (say A and B) just by looking at the cube. Mentally, move the edge piece to the correct edge in which it should lie (i.e. looking at a piece which may be, say, DFR or DFL, mentally move it to the DF edge or just physically rotate the entire cube so that it is in the DF edge but don't actually twist) - then you can tell which edge it is. If my piece after I rotate the entire cube is in the DFR position and is correct for that position (with D colour on the D face) then it is edge I, if it is incorrect for that position (with D colour on the F face) then it is edge J (and by rotating the cube a bit more you could have seen it correctly in that place). It is as easy just to mentally figure it out rather than rotate the whole cube - one thing you can do is put your finger on the high priority colour and follow it around as if mentally performing a slice until you get to the correct edge. Then see whether the colour would be in the correct face if you actually made the move - if so, it should go to that place, so remember that letter, if not remember the other letter for that edge.

e.g. I'm just about to start memorizing the edges. The edge in position A is a Green-Orange edge with Green on the U face. To determine whether this is edge S or edge T (the two edges making up the FL edge) I mentally perform F^{-1} to get it into the FL edge. It goes to the FLU position but with the F (high priority colour) on L face (low priority face) so it really is the edge that needs to go into the FLD position. Thus it is edge T.

You probably need to spend a little time to get used to this but it is actually not too hard. It is harder to remember the sequence of 24 letters!

When you're done memorizing the edges it is time to memorize the centres.

Memorize the centres in blocks of 4. Recall the picture of the 4x4x4 cube.



We represent it here as a net. In the diagram, it is intended that the face at the top of the diagram is the U face and the face at the bottom of the diagram (being opposite) is thus the D face. It really doesn't matter which the other faces are, but for concreteness, when I drew it I intended the F face to be between the U and D faces in the diagram so that the faces from left to right are L, F, R, B. Within each face there are four centre squares. Memorize the block by row (left to right) so memorize the upper left corner then the upper right corner then the lower left corner then the lower right corner. Memorize the blocks in the order of the faces (high to low priority) - so the block in the U face, then the block in the D face, then the block in the F face, then the block in the B face, then the block in the R face and finally the block in the L face.

To memorize a block, we give each colour a number according to priority: 1 to U, 2 to D, 3 to F, 4 to B, 5 to R and 6 to L.

Thus a block may look like 2 3 1 5 and this would mean the upper-left colour (as referred to by the net) was D, the upper-right was F, the lower-left was U and the lower-right was R. (If say that was the second block, on the D face, then the centre labelled 2 would be nearest the F and L faces.)

By memorizing in blocks of 4 you memorize each face's centres separately.

With any luck, the second block shouldn't contain any 1s (as detailed at the outset of 4x4x4 cubes) unless there are only 2 sides with such squares and they are opposite.

Memorizing the corners is the same as in the 3x3x3 cube (or the 2x2x2 cube, except that corner 8 isn't necessarily in the right place).

Once you've memorized the cube you should really take a little break and come

back and see if you still have it in mind. It is important to be able to remember everything (especially the edges which we will complete last) for a very long time.

This done we are ready to don the blindfold.

3.11 Donning The Blindfold

Don the blindfold.

3.12 Orienting The Corners

Do this exactly as detailed in the 2x2x2 case or 3x3x3 case. It doesn't mess anything up (edge,centre or corner positions).

3.13 Permuting the corners

Get the corners into place just as in the 3x3x3 cube. Leave corners 3 and 4 to last if possible in case you have bad parity (i.e. have to switch just two corners) and then, if you need to switch corners 3 and 4 as per the 3x3x3 cube. Be aware that in the 3x3x3 cube doing this switched the edges in positions 1 and 2. In the 4x4x4 it will switch the edge in position A (the UFR position) with that in position D (the UBL position) and the edge in position B (the UFL position) with that in position C (the UBR position) (if you think about doing it to a solved cube you will see that it has to be so in order to keep the U colours on the U face).

Thus here you would have to alter the first 4 letters in your mental edge map. For this reason, you may prefer to leave switching these corners until you are ready to start the edges (as long as you remember to do so) and to go on to the centres.

3.14 Solving The Centres

Let us solve the centres. Solving the centres will not affect the edges or the corners.

First suppose that the U face has no U centre squares. In this case you should have an U centre square in each of the F, B, R and L faces.

If the U face has 4 different types of centre square then at least one of these type must also appear on one of the F, B, R and L faces (as there are 12 such other squares and only 4 spaces in the D face).

Without loss of generality we can suppose it is the F face (if not, rotate the entire cube so that it becomes the F face (with the U face still as U face) and then after doing the moves below undo this rotation (¶)). Here is what you should do:

rotate the U face so that the common colour is in the 4th position of the centre squares (near the F and R faces) relative to the cubes current (perhaps rotated)

position (\dagger) and rotate the (new) F face so that the common colour is in the 4th position of that face (\ddagger). Now do

$$D_2^{-1}R_2D_2R_2^2D_2^{-1}R_2D_2$$

(where D_2 is the move of the slice adjacent the D face in the same direction as D and similarly for R_2).

Rotate the (new) F face so that the U colour is in the 4th position of the centre square ($*$) and do the move

$$D_2^{-1}R_2^{-1}D_2R_2^2D_2^{-1}R_2^{-1}D_2$$

then undo the rotation ($*$) then the rotation (\ddagger) then the rotation (\dagger) and finally if necessary undo the whole cube rotation (\blacklozenge).

The effect of this move is to put an U centre square into the U face (where the common coloured square was) and to put the common coloured centre square where the U centre square was. (At least it appears so, actually it is a 3-cycle but one common coloured square goes to where another was.)

In this was you get an U centre square into the U face.

Alternatively, you may have no U centre squares in the U face but two centre squares of the same colour in the U face. If they are not the D face colour then rotate the cube so that the face of the appropriate colour is in Front (with the U face still U). (f)

If they are the D face colour, we'll trade one for the U centre square from the F face so we don't need to rotate.

Rotate the U face until the two equal colours are both near the R face (2nd and 4th positions) (α) and rotate the F face until the U centre square is in the 4th position (β).

Now do this:

$$F_2^{-1}R_2^{-1}F_2R_2^2F_2^{-1}R_2^{-1}F_2U F_2^{-1}R_2F_2R_2^2F_2^{-1}R_2F_2U^{-1}$$

followed by undoing β then α then, if necessary f .

The effect of this will be to move a centre square of the common colour to where the U centre square was, the U centre square to the 2nd square of the common colour and the 2nd square of the common colour to the where the first square of the common colour was. You should really try this type of stuff out visually first before you attempt to do it blindfolded to see what its going on. You will see that it looks as if we just swapped two centre square pieces. Remember to keep track of where the squares go, mentally.

So we can now assume we have an U centre square in the U face.

Now, you can move any U centre squares from the F, B, R or L faces to the U face using the techniques above. (Move an U centre square to the U face displacing another U centre square in the U face which displaces a non-U centre square in the U face which comes back to the position of the original centre square.)

By this means you can clear the F, B, R and L faces of U centre squares.

If you have any U centre squares in the D face (meaning that you should have

started off with all U centre squares in the U and D faces) then you'll need to move them to the U face too.

If there are D centre squares in the D face and any of the F, B, R or L squares then 3-cycle two D centre squares (one in the D face and one not) with the U centre square in the D face) to get it out of the D face and proceed by methods already described to get it into the U face. If not, but there one of the F, B, R or L faces has 2 D centre squares then 3-cycle these with an U centre square from the D face and proceed to move the U centre square to the U face.

If not, but there is at least one D centre square in one of the F, B, R or L faces, use a 3-cycle that moves the D centre square to an U centre square in the D face, that U centre square to one of the other centre squares (in the face that contained the D centre square) and that other centre square to the square that position that was occupied by the D centre square. You'll have to make 3 adjustments to the mental map of the centres instead of the usual 2. Then you can move the U centre square to the U face.

Finally, if there is at least one U centre square on the D face and no D centre squares on any of the F, B, R or L faces (so that there is a D centre square in the U face then you'll need to do this: 3-cycle an U-centre square in the D face to, say, the 4th centre square position of the F face, which should replace a D centre square in the D face which in turn should replace the U centre square from the D face. Now cycle the U centre-square from the 4th centre square position of the U face to a square occupied by an U centre square in the U face which should go to a place occupied by a D centre square in the U face which should go to the 4th position of the centre squares of the F face. Then cycle the D centre square in the 4th position of the F face to a square occupied by an D centre square in the D face which should go to the square occupied by the piece you originally took from the 4th position of the centres of the F face (near the start of the move) which then goes back to the 4th position of the centres of the F face. (If you still had an U centre square in the D face - which can happen at most once- then you should instead move this to the 4th position of the F face and switch it again for a D centre square from the U face before finally getting the non-D centre square back to the 4th position of the centres of the F face.) OK, if you've followed so far, you have the centres of the U face solved. (NB The strategy above has many simplifications if you get used to the moves. This is really more of a beginner's guide.)

We now solve the centres of the D face, if they aren't already done. One possibility is that there are no D centre squares in the D face. In this case, there are either 2 centre squares of the same type in the D face or they are all different. If they are all different then choose a face with a D centre square and cycle it to the D face bringing back up a centre square of the appropriate colour to replace some other centre square (if possible of the same colour) which moves to where the D centre square was). Even if they are not all different but there is a centre square in the D face whose correct face has a D centre square in its centre we can do the same thing. If they are not all different and D centre squares only occur in faces whose centre squares do not lie in the D face then at least one of the F, B, R or L faces has at least 2 D centre squares and we can use 2 of these

in a 3-cycle with a square from the D face.

In this way, we can get a D centre square in the D face.

Use this to get the other D centre squares in the D face (using 3-cycles, push a D-centre square from another face to a D centre square in the D face which goes to a non-D centre square in the D face which replaces the D-centre square from the non-D face).

Now we do the same sort of thing to complete the centre squares on one of the other faces.

Choose, if possible a face (F, B, R or L) such that none of its centre squares are on the opposite face. If such a face also has one of its own centre squares in place then you can use this to 3-cycle in the remaining centre squares from the adjacent faces.

If not you must 3-cycle in a correct centre square from an adjacent face. In this event there are at most 3 colours in the 4 centre squares of the chosen face so there is a repeated colour - we can use two of these plus the correct centre square in an adjacent face to make the 3-cycle like a 2-cycle which makes updating the mental image easier. Then we can proceed to get all the other centre squares in.

Otherwise, for each face of F, B, R or L, at least one of its correct centre squares is on the opposite face.

Choose one of the four faces with the fewest number of correct centre pieces on the opposite face. There are 3 possibilities:

- All the correct centre squares are on the opposite face.
- Some of the correct centre squares are on the opposite face and the rest are on the correct face.
- At least one correct centre square is on an adjacent face.

In the last case, you can use the correct centre square on the adjacent face to 3-cycle correct centre squares from the opposite face to that adjacent face and then no correct centre squares will be on the opposite face so we can complete as above.

In the case that all the correct centre squares are on the opposite face we are in the situation where this is the case for each of the four faces (by earlier assumptions). Switch each correct centre square one at a time with an adjacent face (the same adjacent face) then switch them to the correct face. Now switch one at a time from the opposite face to the remaining adjacent face and finally from the opposite face to the first adjacent face. This is quite a few moves but will solve all the centres.

If some of the correct centre squares are on the opposite face and the rest are on the correct face then by hypothesis the same situation holds for the centres of the adjacent faces (none of which is complete). 3-cycle a correct centre square to a centre square in an adjacent face which goes to another centre square in the same face which replaces the centre square from the opposite face. Doing

this you are then in one of the previously discussed earlier cases and can solve the centres of the chosen face.

Now we have 3 centres to go.

Solve either of the 2 centres not opposite the face just solved (to leave 2 adjacent faces centres the end).

For concreteness, suppose we had just solved the B centres. We now solve either the R centre or the L centre.

If there are no R centre squares on the L face, solve the R centre by 3-cycling R centre squares from the F face until the R centre is solved.

If there are R centre squares on the L face but no L centre squares on the R face, solve the L centre by 3-cycling L centre squares from the F face until the L centre is solved.

If neither of these occurs so that there are R centre squares on the L face and L centre squares on the R face then if the F centre is not solved there is either a R centre square or a L centre square on the F face. Use this to cycle similar centre-squares to the F face (from the L centre or R centre respectively) and proceed to solve the R centre or L centre (respectively).

If the F centre is solved then 3-cycle a L centre square from the R face with 2 F-centre squares to get a L centre square in the F face. Then you can proceed to solve the L centre as earlier described.

Finally, we have just 2 centres to solve and they are adjacent. 3-cycle centres between them until complete.

If you can follow this and have concentrated really hard then by now all your centres should be solved.

3.15 Solving The Edges

If you left some corners to be solved (corners 3 and 4 from the permuting the corners stage) then use move P10 (of the ordinary 3x3x3 cube). This will finish your corners and will switch 4 edge pieces (that in position A with that in position D and that in position B with that in position C).

It's now time to join the edges.

The basic move will be a 3 cycle of edge pieces:

$$F_2^{-1} LsFRsU^2LsFRs B^2U^{-1}RsB^2LsU^{-1}B^2 F_2 LsFRsU^2LsFRs B^2U^{-1}RsB^2LsU^{-1}B^2$$

moves the edge in position E to position G, the edge in position G to position H and the edge in position H to position E. If you use F_2^2 in place of F_2^{-1} and in place of F_2 then you get the same thing but with 'E' replaced throughout by 'M'. If you use F_2 in place of F_2^{-1} and F_2^{-1} in place of F_2 then instead you get the same thing but with 'E' replaced throughout by 'O'.

So using edge twists, bring edge pieces of the same type (A & B, C& D) et cetera into positions where this move can be used on them to bring them together. For instance if in positions G and H we had edges Q and X respectively then we would want to get either edge R into one of the positions 'E', 'M' or 'O' or else edge W into one of the positions 'F', 'N' or 'P' and use the basic move. Once

done undo whatever twists were necessary to get edge R or W into position. You will then have a completed edge somewhere (keep track of where it was - if it is edge QR then they will be in positions G and H (Q in H and R in G) - otherwise it will be elsewhere, wherever edge W was originally (the edge it was paired with will be in position G, Q will be in position H and X will be paired with W which will have retained its initial position.)

Once you have correctly assembled an edge you can 3-cycle it into position as with the 3x3x3 cubes. Be careful as to the exact positioning of all the new edges (in fact 6 edges are changing place, 2 3-cycles worth). An edge which was memorized as FO may suddenly become OF in the new mental map because of the way the letters are assigned. The best way to see what is going on is to try and mentally picture what happens to each edge e.g. in the U face:

	C	G	
H			B
W			A
	T	U	

becomes (after $R^2UFsR^2BsUR^2$)

	U	T	
H			C
W			G
	A	B	

- note that the edge memorization would have started U T G C A B W H but becomes B A T U G C W H (so two of the orders have been reversed).

If you can keep this straight you will be well on the way.

The correct move to place A and B above would either be to do R^{-1} followed by a 3-cycle in the F face then R or to flip the UR edge and some other edge (say the UL edge) and then do the 3-cycle (if you then flip the UB and UL edges the new edge memorization would start A B U T G C W H and each pair would be have the same order as before).

So, doing this you can complete several edges. If you complete the edges QR (FR edge), ST (FL edge), UV (BR edge) and WX (BL edge) first then you will find there are not many twists needed to get edges in place for joining the remaining edges. Edges can still be flipped as in the 3x3x3 case, where helpful of course, and you can easily complete most of the other edges, using methods similar to the 3x3x3 cube to place edges (possibly needing to flip as well). Ultimately then you can finish the D face and also the UR and UL edges and have edge pieces A and B in the same edge and edge pieces C and D in the same edge. Now there are two things that can go wrong. If the edge CD is in the UF edge position you need to swap the UF and UB edges.

This move is effected by $R_2^2U^2R_2^2U^2U_2^2R_2^2U_2^2$ (as detailed in C. Hardwick's 4x4x4 solution page, <http://www.speedcubing.com/chris/4-solution.html>). Having done this, if necessary, we can ensure that edge C is in position C by flipping the UF and UB edges (again, if necessary).

The remaining possibility is that the UF edge needs to be flipped (edge B is in position A and edge A is in position B).

To do this use the move $R_2^2 B^2 U^2 L_2 U^2 R_2^{-1} U^2 R_2 U^2 F^2 R_2 F^2 L_2^{-1} B^2 R_2^2$ (also from C. Hardwick's 4x4x4 solution page).

OK, if you're still with me you should now be ready to put down the cube. (If you're not, maybe this page can win a citation from the Campaign for Clear English.)

3.16 Putting The Cube Down

Put the cube down.

3.17 Removing The Blindfold

Remove the blindfold.

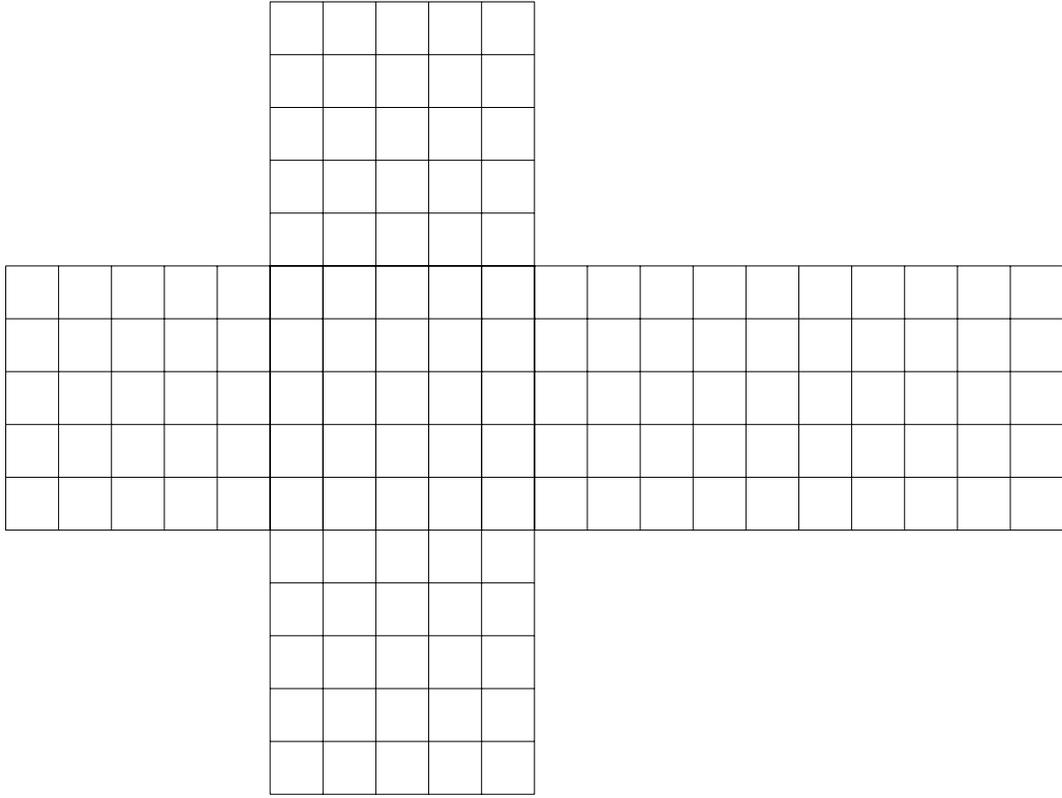
If you concentrated really hard and weren't disturbed and memorized the cube well at the outset and understood the instructions and were able to mentally make all the changes necessary your cube should now be solved. If not, but your cube is solved anyway, you are really lucky (or are in possession of another technique).

If you didn't solve it, try harder next time. (It took me a few goes to get it right.)

Note: this method can be simplified somewhat in terms of all the twists and things but I put down what I thought would be a more basic method.

If you can do this consistently you are ready for the next step, the 5x5x5.

4 5x5x5 Cubes



I haven't tried this yet, but I have a plan of attack. It shouldn't be too much harder than the Revenge in principle.

4.1 Memorizing The Cube

As with the smaller cubes you should have a fixed U face and F face which will make it easier to memorize the position of the cube and not slip up.

Memorizing the corners should be done in the same way as for the 3x3x3 cube (you'll need to remember at least 7 (unless you want to get technical on the parities and then depending how you proceed you may get away with 6 - even then you'll need to remember at least 7 orientations).

You should do this after remembering the other details - I put it here just because of its similarity with other cubes.

To memorize the edges we can think of the edges comprising the edges of a Rubik Revenge with the edges of an ordinary Rubik's cube between them. Thus, the UF edge has 3 pieces - we can think of the outer ones as edges of a Revenge and the inner one as the edge of a regular cube.

We memorize 3 sequences for the edges:

- One sequence of letters A-X for the Revenge like edges.
- One sequence of numbers 1-12 for the ordinary cube-like edges.
- One sequence of orientations 0-1 for the ordinary cube-like edge permutations.

The sum of the orientations must be divisible by 2 or else you can't solve the cube.

(Also the ordinary cube-like edges permutation must have the same signature as the corner permutation, both odd or both even.)

To memorize the centres we work as with the Revenge - there are 6 blocks to remember but this time each block has 9 entries (the 5th one will be the colour of the face) and the order of memorization should be the same as with the Revenge (i.e. the U block first, then the D block, et cetera and within each block memorize in horizontal strips from left to right, the strips memorized from up to down with respect to the net which has faces corresponding to the one used for the Revenge).

So at the end you will have memorized:

- A sequence of 24 letters (A-X in some order).
- A sequence of 12 numbers (1-12 in some order).
- A sequence of 12 numbers (0s and 1s with an even number of each).
- Six sequences of 9 numbers (comprising 1s, 2s, 3s, 4s, 5s and 6s, 9 of each in total, the 5th one of the kth sequence being k for $k=1,\dots,6$).
- A sequence of 8 numbers (1-8 in some order such that the signature is the same as that of the first sequence of 12 numbers).
- A sequence of 8 numbers (0s, 1s and 2s the sum of which is divisible by 3).

You are now ready to don the blindfold.

4.2 Donning The Blindfold

Don the blindfold.

4.3 Orienting The Corners

Orient the corners just as you would for smaller cubes.

4.4 Permuting The Corners

Permute the corners 1,2 and 5-8 into the correct positions as with smaller cubes. If corners 3,4 are correctly placed excellent. If not, leave this part of the solution until later.

4.5 Solve The Centres

Solve the corners of the centres just as for the Rubik's Revenge.

In solving the cross piece of the centres the basic move is the 3-cycle $R_2D_3R_2^{-1}D_3^2R_2D_3R_2^{-1}F^{-1}R_2U_3R_2^{-1}U_3^2R_2U_3R_2^{-1}F$ which takes the centre square from the 6th position of the F centres to the 8th position of the F centres, the centre square from the 8th position of the F face to the centre square of the 6th position of the R face and the centre square from the 6th position of the R face to the centre square of the 8th position of the F face. Variants can be used for instance F and F^{-1} could be replaced by F^{-1} and F or both by F^2 . We could also swap the Ds and Us or the Rs with Ls.

Crucially, if we used R_3 instead of R_2 throughout then we would get a bit of trouble. Things don't work quite as expected.

In face $R_3D_3R_3^{-1}D_3^2R_3D_3R_3^{-1}$ will switch the 2nd centre square of the F face with that of the B face and the 2nd centre square of the R face with that of the L face which could in itself be useful for swapping across pairs of opposite faces. After some time (in a similar way to the centre corners you can finish the centres off.

4.6 Orient The Centre Edge Pieces

Permute the last 2 corners (3 and 4) if needs be by the standard move noting that this switches the UF and UB edges as well as the order in which the individual edges are memorized.

The move $FsF_2sUF^{-1}F_2^{-1}U^{-1}Fs^{-1}F_2s^{-1}LFF_2L^{-1}F^2ULsL_1sF^2RsR_1sUF^2R_2^{-1}U_3R_2U_3^2R_2^{-1}U_3R_2U^{-1}R_2^{-1}D_3R_2D_3^2R_2^{-1}D_3R_2U$ will flip the centre edges from the UR and UL edges and that is all it will appear to do (if you have already solved the centres, otherwise it will not).

The move $LsL_2sFRsR_2sU^2LsL_2sFRsR_2sB^2U^{-1}RsR_2sB^2LsL_2sU^{-1}B^2$ will flip the centre edges from the UB and UL edges and that is all it will appear to do (if you have already solved the centres, otherwise it will not).

Doing this you can correctly orient the centre edge pieces.

4.7 Permuting The Remaining Edges

By using moves from the 4x4x4 solution pair non-central (Revenge-type) edge up to their corresponding centres so that they are in the correct place (match with orientation of centre edge piece). You'll be able to do this for at least 11 of the edges quite easily and as each edge is made place it using techniques from 3x3x3 blindfolding.

The final edge may require a bit more work as the Revenge-type edges may need to be swapped.

Again you can use the C. Hardwick move adapted to this situation if this case arises:

$$R_2^2B^2U^2L_2U^2R_2^{-1}U^2R_2U^2F^2R_2F^2L_2^{-1}B^2R_2^2.$$

It appears as exactly the same move notationally.

Now you are ready to remove the put down the cube.

4.8 Putting The Cube Down

Put the cube down.

4.9 Removing The Blindfold

Remove the blindfold.

Your 5x5x5 cube should now be solved.

It's time to go beyond the physical.

5 Bigger Cubes

In bigger cubes you can use the same sorts of techniques if you can find the cubes.

Here is the strategy. You will need to memorize:

- A number of sequences of 24 letters (A-X), the precise number being $n-1$ for a cube of side length $2n$ or $2n+1$. Memorize them from the outside of the edge (corner excluded) in.
- A sequence of 12 numbers (1-12) if the side length of the cube is odd.
- A sequence of 12 numbers (0s and 1s) if the side length of the cube is odd, there being an even number of 0s and an even number of 1s.
- 6 sequences of $(n-2)^2$ numbers (between 1 and 6) if $n \not\equiv 3$.
- A sequence of 8 numbers (1-8).
- A sequence of 8 numbers (0s, 1s and 2s) such that their total is divisible by 3.

Again, it is not essential to remember quite all of the information but you may as well.

Don the blindfold.

The solving strategy should be to orient the corners first using methods as above, to permute most of the corners (possibly excepting 3 and 4) again as detailed above.

Solve the centres using methods as above. You could do them in groups of 4 (each centre square can occupy exactly 4 centre square positions per face, except the very central squares in cubes of odd side length).

Once this is done, if you are in an odd length cube situation, make the obvious generalizations of the 5x5x5 case to orient the centre edge pieces.

Now piece all the edges together as in the 4x4x4 or 5x5x5 cases. You'll be able to get all the edges (except possibly one which we can assume to be the UF edge - here I mean the edge that should be in the UF position when solved)

correctly put together and all the edges (except possibly 2 if the cube has even side length) in the correct places (and if 2 we can assume they are the UF and UB edges).

If the UB edge is in the UF position use the C. Hardwick move (as in the 4x4x4 case) to switch the UB and UF edges. Here you will need to replace $R_2^2 U^2 R_2^2 U^2 U_2^2 R_2^2 U_2^2$ by a more general move. R_2^2 is replaced by $R_2^2 R_3^2 \cdots R_k^2$, where the side length is $2k$ and U_2^2 is replaced by $U_2^2 U_3^2 \cdots U_k^2$.

Finally, if the edge in the UF position isn't quite right you need to generalize the other C. Hardwick move.

Instead of R_2 and L_2 and their inverses/squares use an R_j , L_j and their inverses/squares for every part of right half of the UF edge which is in the wrong place (i.e. has the F colour on the U face) - where by part I mean intersection with the j th slice from the right. (Possible values of j are $2, \dots, k$ if the side length is $2k$ or $2k + 1$, although you won't always need all of them.)

Put the cube down.

Remove the blindfold.

You should be done - I'll leave it to someone else to figure out how to do higher dimensional cubes blindfolded. :)

6 Memorizing The Sequences

I'll write this part later - just some things you can associate different pairs of numbers (or occasionally letters to).