

4x4x4 Cube Synthesizer – Centers

Introduction

Revenge Cubes are **4x4x4** cubes. They may be solved for a *single* face out of six to display pictures or patterns on a selected front face.

A way of solving a single face is first to solve the 4 centers, then the 4 dedges (double edges) and finally the 4 remaining corners cubes. This is very similar to the method used for solving the *first* layer of a regular Revenge Cube.

By twisting and rotating some parts of the cube, it is possible to move selected cubelets from any face to the front face. Note that each letter, number or symbol on a solved face should have the right orientation, i.e. should generally be oriented North (0°).

Maneuvers used for twisting and rotating parts of a cube are coded as a series of letters called an *algorithm*. An algorithm is then a code for a sequence of moves used to change the state of a cube from an *initial* (unsolved) state to a *final* (solved) state.

The *initial* state of a cube is given by a particular layout of letters, numbers and symbols shown on the cube *texture* whereas the *final* state is given by what we would like to see displayed on a selected front face. This is where we would need a software tool for *automatically* generating an algorithm to set the cube to a *user-selected* final state. This is what is called *synthesis*, which is just the reverse of *analysis*. and the software tool to do this is called a *Synthesizer*. The Synthesizer input data is the *final* state data.

Basic algorithms are used to change the state of each front face cubie from an initial to a final state. Synthesized algorithms are then basic algorithms that have been concatenated.

Download CubeSynthesizer4C Version 1.0

Microsoft Excel 2007

<http://www.mementoslangues.fr/CubeDesign/CubeSynthesizer4C.xlsm>

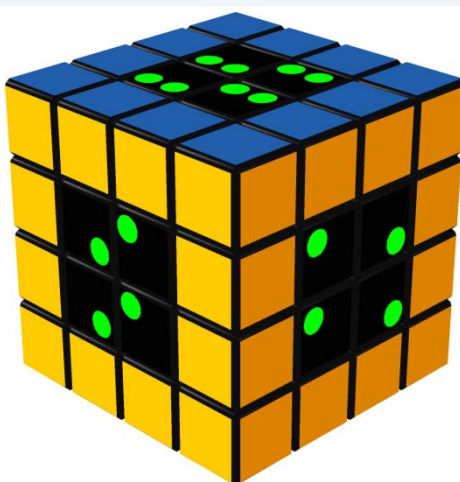
Microsoft Excel 97-2003

<http://www.mementoslangues.fr/CubeDesign/CubeSynthesizer4C.xls>

Reference Cube



4x4x4 Demo Cubes – Centers
Demo Dot Matrix Cube



Demo Clock Cube



4x4x4 Cube Centers: Notations

Isolated (or strings of) letters, numbers, characters, symbols or pictures are placed on center cubies. These may be oriented **N**orth (0°), **E**ast (90°), **S**outh (180°) or **W**est (270°). Center cube notations are abbreviated as follows:

- Center **T**op **L**eft (**CTL**)
- Center **T**op **R**ight (**CTR**)
- Center **B**ottom **L**eft (**CBL**)
- Center **B**ottom **R**ight (**CBR**)

Notations & Solving Sequence							
Center Cube Notations				Solving Centers in 4 Steps CW			
	CTL	CTR			Step 1	Step 2	
	A	A			A	A	
	CBL	CBR			Step 4	Step 3	
	A	A			A	A	

Center Cube Moves – Step 1							
To Front Face – CTL North				From Any Face – N E S W			
	CTL				N	E	
	A				A	➤	
					W	S	
					⬅	⬇	

Center Cube Moves – Step 2

To Front Face – CTR North

		CTR	
		A	

From Any Face – W N E S

	W	N	
	A	A	
	S	E	
	A	A	

Center Cube Moves – Step 3

To Front Face – CBR North

		CBR	
		A	

From Any Face – S W N E

	S	W	
	A	A	
	E	N	
	A	A	

Center Cube Moves – Step 4

To Front Face – CBL North

	CBL		
	A		

From Any Face – E S W N

	E	S	
	A	A	
	N	W	
	A	A	

Center Cubes Location

		Up	Up					CTL	CTR		
		Up	Up					CBL	CBR		
Left	Left	Front	Front	Right	Right	CTL	CTR	CTL	CTR	CTL	CTR
Left	Left	Front	Front	Right	Right	CBL	CBR	CBL	CBR	CBL	CBR
		Down	Down	Back	Back			CTL	CTR	CTL	CTR
		Down	Down	Back	Back			CBL	CBR	CBL	CBR

Center Cubes States Numbering and Orientation – Initial State (Texture State)

Initial State Numbering

Initial State Orientation (degrees)

		9	10					0	0		
		11	22					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Example: Center Cubes States – Step 1: From R [CTL, N] To F [CTL, N]

Numbering

Orientation (degrees)

		9	10					0	0		
		11	22					0	90		
13	12	5	2	18	6	0	270	0	0	270	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	1	21	14			0	90	0	0
		19	20	23	24			0	0	0	0

Algorithm Synthesizer

Introduction

A computer program named *CubeSynthesizer4C* has been designed for synthesizing algorithms for moving center cubelets on 4x4x4 cubes that need to be solved for a *single* face. The program has been developed using Microsoft Office Excel and Visual Basic Editor. There is only a Developer's version of this program available at present.

The program can be used as follows:

- 1- Open *CubeSynthesizer4C* in Excel
- 2- Press Ctrl+Shift+S to display the Synthesizer Input Form
- 3- Select a cube from the Form
- 4- Click the OK Button and wait until algorithm synthesis is completed
- 5- Browse through the list of synthesized algorithms in Worksheet 'Main'
- 6- Copy a selected algorithm in [CubeTwister](#) or in an applet

Algorithms

A 4x4x4 Reference Cube has been used to check basic algorithms and to fill in lookup tables with numbers indicating the cube state. All basic algorithms are based on *commutators* and do not modify any facelet on the *Front* face other than the origin or destination facelets. A *complete* algorithm for a whole front face would then need up to 16 basic algorithms whereas a composite algorithm for the 4 centers is obtained by *concatenating* a maximum of 5 basic algorithms.

Synthesized algorithms are basic algorithms that have been concatenated. Finding basic algorithms can be done *manually* by searching the path of letter 'A' on a [cube wire grid model](#), from an initial to a final location. The tip of Letter 'A' is used to show the orientation of a facelet.

Short Program description

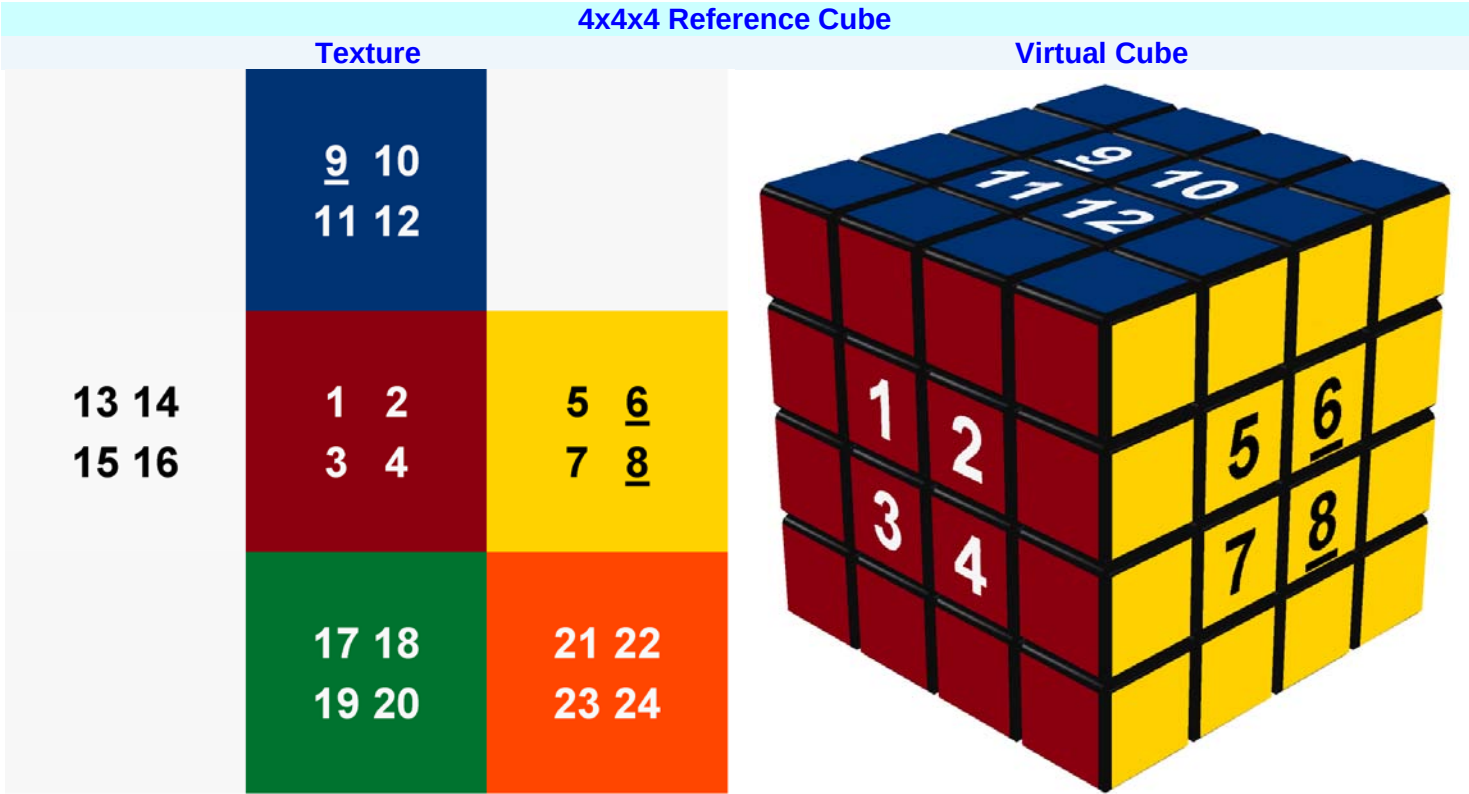
There are 5 steps for solving the 4 centers on a front face. Step 0 is the first step, used to bring any of the 6 faces on front, with the correct orientation. Step 0 is simply a combination of cube rotations. Steps 1 to 4 are then applied CW (ClockWise), 1 step per center facelet. There is an option for optimizing the order of steps 1 to 4 to find the shortest length algorithm. In this case, algorithms are computed for $4! = 24$ sequences and the shortest length algorithm is selected at the end of the optimization process. These sequences are shown in the Table below.

Algorithm Length Optimization – The 24 Sequences of Steps											
1	2	3	4	5	6	7	8	9	10	11	12
Step 1	Step 1	Step 1	Step 1	Step 1	Step 1	Step 2	Step 2	Step 3	Step 3	Step 4	Step 4
Step 2	Step 2	Step 3	Step 3	Step 4	Step 4	Step 1	Step 1	Step 1	Step 1	Step 1	Step 1
Step 3	Step 4	Step 2	Step 4	Step 2	Step 3	Step 3	Step 4	Step 2	Step 4	Step 2	Step 3
Step 4	Step 3	Step 4	Step 2	Step 3	Step 2	Step 4	Step 3	Step 4	Step 2	Step 3	Step 2
13	14	15	16	17	18	19	20	21	22	23	24
Step 2	Step 2	Step 2	Step 2	Step 3	Step 3	Step 3	Step 3	Step 4	Step 4	Step 4	Step 4
Step 3	Step 3	Step 4	Step 4	Step 4	Step 4	Step 2	Step 2	Step 2	Step 2	Step 3	Step 3
Step 4	Step 1	Step 1	Step 3	Step 1	Step 2	Step 4	Step 1	Step 1	Step 3	Step 1	Step 2
Step 1	Step 4	Step 3	Step 1	Step 2	Step 1	Step 1	Step 4	Step 3	Step 1	Step 2	Step 1

For each step, basic algorithms are automatically selected in look-up tables. A synthesized algorithm is then obtained by concatenating 5 basic algorithms. In order to shorten the synthesized algorithm length, *trivial* combinations between successive basic algorithms such as **B B'** or **MF MF'** are suppressed or simplified when concatenating basic algorithms.

Examples

Example #1: 4x4x4 Reference Cube



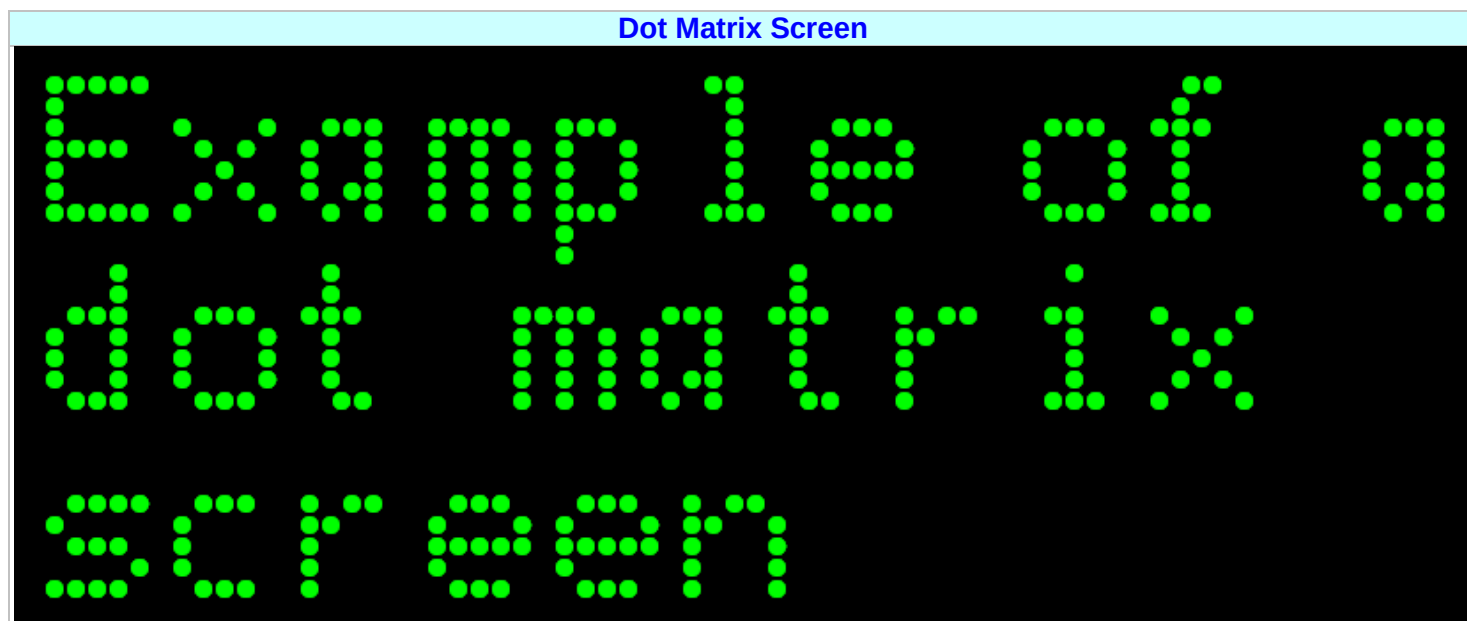
4x4x4 Reference Cube – Basic Algorithms Examples	
Step 1: From R [CTL, N] To F [CTL, N]	Step 2: From U [CBR, E] To F [CTR, N]



Number '5' is brought from face R to face F (+0°)	Number '12' is brought from face U to face F (+270°)
Basic Algorithms (Commutators)	
MF' MU' MF MU	MU MF' MU' MF

A 4x4x4 Reference Cube is used to check basic algorithms and fill in lookup tables with numbers indicating the cube state. All basic algorithms are based on *commutators* and do not modify any facelet on the *Front* face other than the origin or destination facelets.

Example of a Dot Matrix Screen



The screenshot shows the 'CubeSynthesizer4C - Microsoft Excel' application. The main window displays a spreadsheet with a yellow background. The 'Moves' column (B) contains the following text:

- 1 CubeSynthesizer4C - 4x4x4 Calendar & Picture Cubes - Developer's V
- 2 Revenge Cube
- 3 Synthesized algorithms
- 4 B' MD' MB MD MB' ML MB' ML' MB B2 MD' MF' MD MF MR MF' ML' CU MF MD' MF' MD MF MU MF' MB' MU' MB'

The 'Synthesizer Input Form' dialog box is open, showing the 'Clock Cubes' tab. The dialog has the following sections:

- Clock Cubes:**
 - Cube Front Face: Front Face (selected), Right Face, Up Face, Left Face, Down Face, Back Face.
 - Face Orientation: North (0°) (selected), East (90°), South (180°), West (270°).
 - Algorithm: Optimized (checked).
 - Main Worksheet: Clear Contents.
- Revenge Cube Centers:**
 - Center Top Left: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24.
 - Center Top Right: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24.
 - Center Bottom Left: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24.
 - Center Bottom Right: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24.

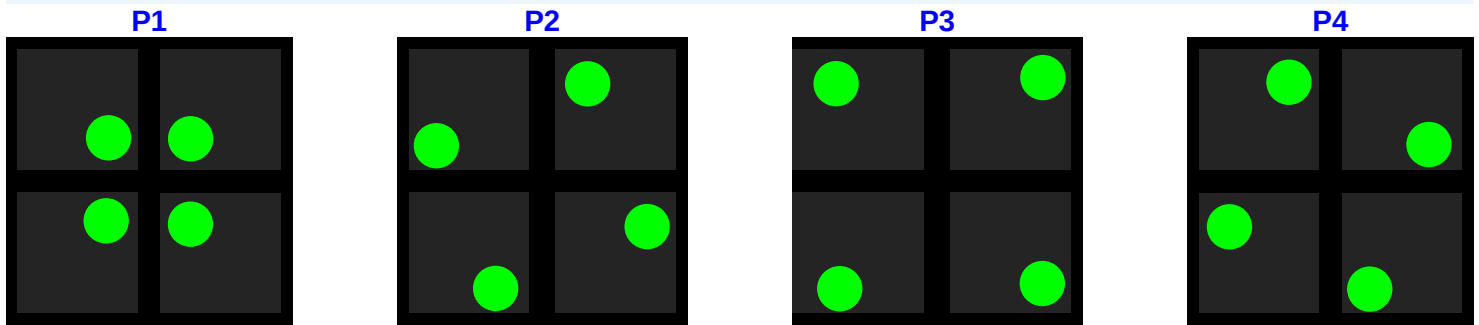
The 'OK' button is visible at the bottom of the dialog box.

Cube Synthesizer 4C

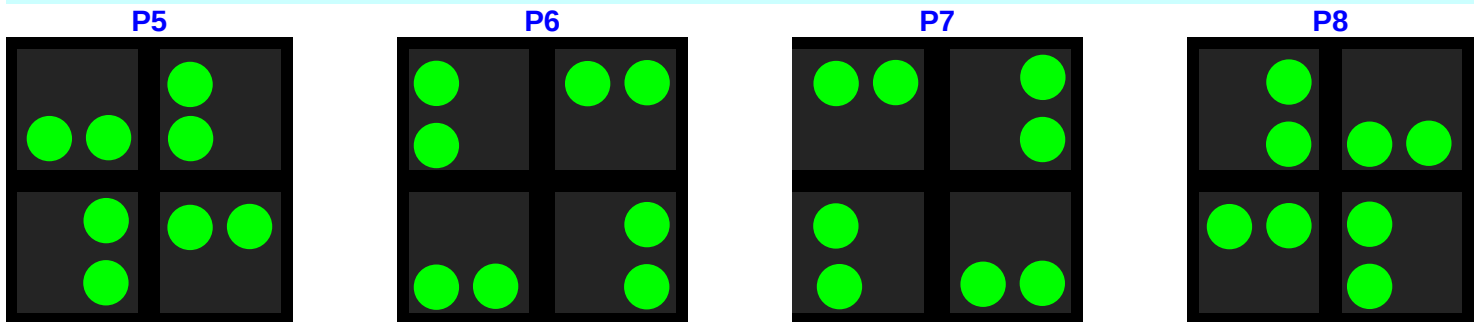
Dot Matrix Cube Patterns on Center Cubes

Center Cubes Patterns – Basic patterns Location: CTL

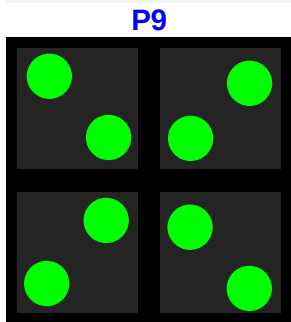
1-dot Patterns – 4 Patterns



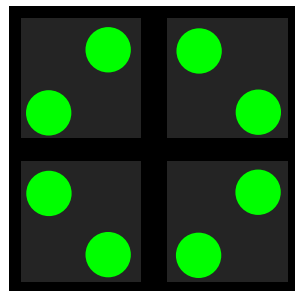
2-dot Patterns – 6 Patterns



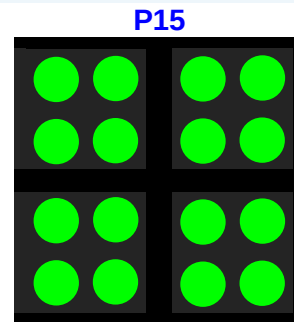
2-dot Patterns (cont'd)



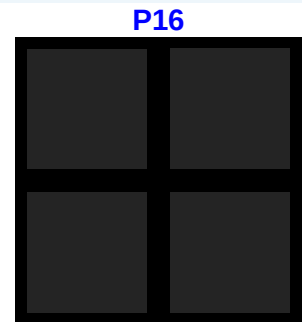
4-dot Pattern



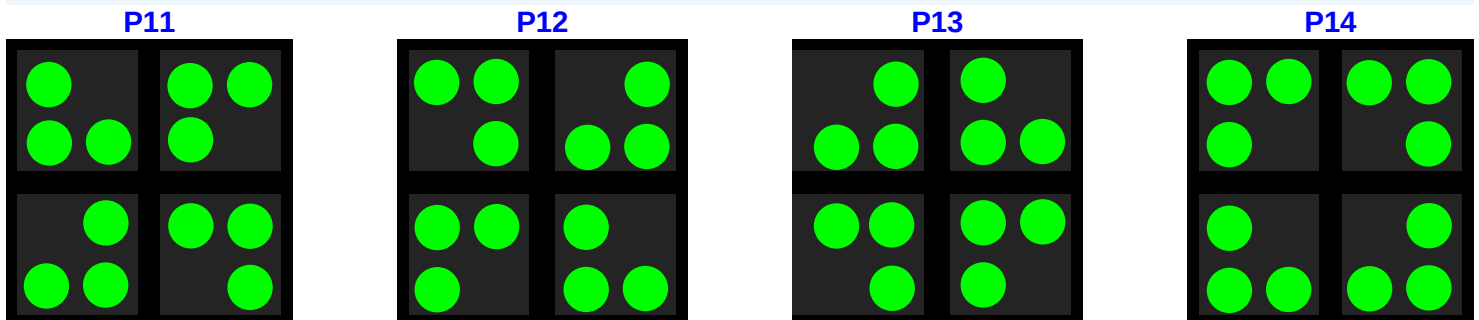
0-dot Pattern



0-dot Pattern



3-dot Patterns – 4 Patterns



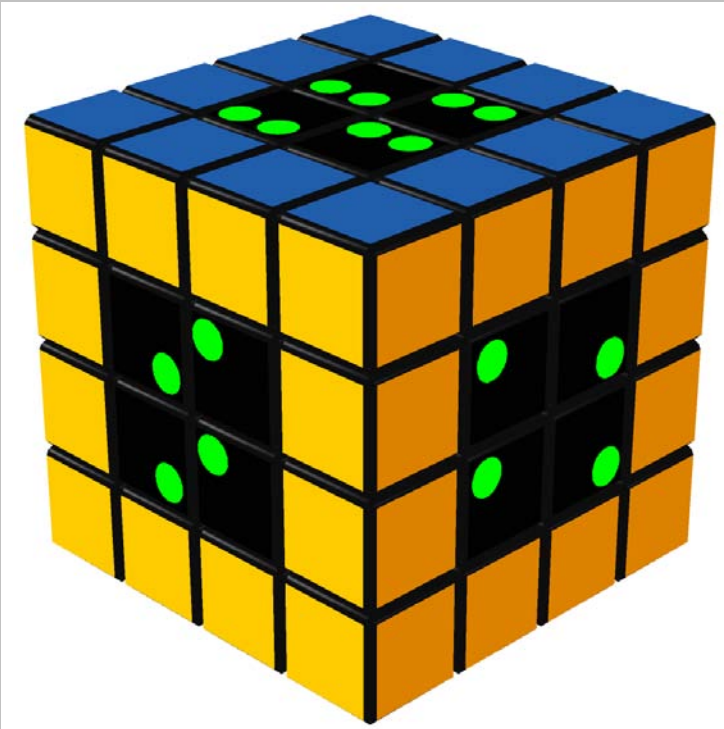
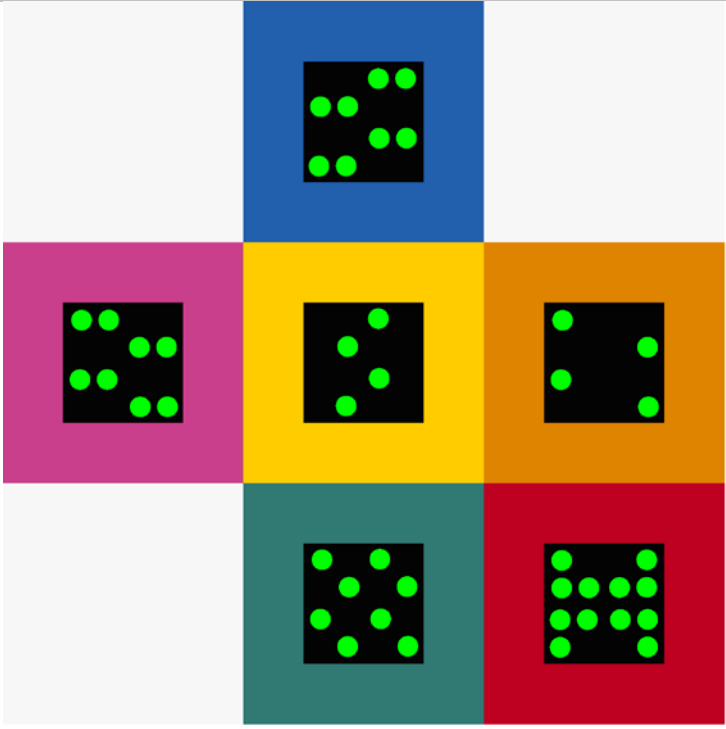
Selecting Dot Matrix Cube Patterns

There is a total of 16 different patterns for 24 center cubes. So, we have to make a choice on the most suitable patterns. Patterns P1 – P12 have been selected as explained below:

- 1- There is no unique choice: other patterns could also have been selected as well.
- 2- Only 12 basic patterns have been selected. The other 12 patterns are the same but obtained through a 180° rotation.
- 3- All 1- and 2-dot basic patterns have been selected.
- 4- Only two out of four 3-dot basic patterns have been selected.
- 5- 0- and 4-dot patterns have not been selected.

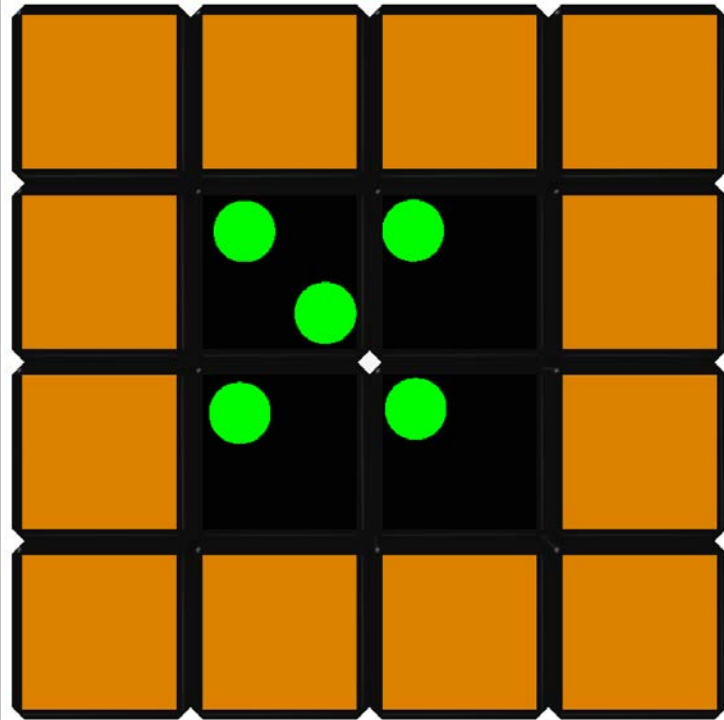
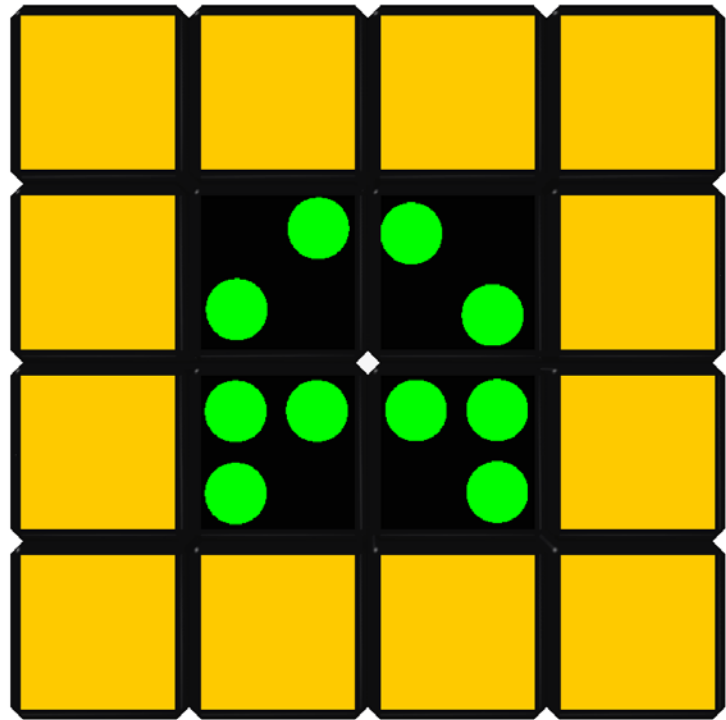
Examples of Dot Matrix Patterns on Center Cubes

R4 Dot Matrix Cube (Demo)



TextureVirtual Cube

R4 Dot Matrix Cube (Demo) – Examples



Virtual Cube (Capital Letter 'A') – Front FaceVirtual Cube (Small Letter 'x') – Right Face

Synthesized Algorithm (Letter 'A')

B' MD' MB MD MB' ML MB' ML' MB B2 MD' MF' MD MF MR MF' MR' MF B' MR' MF' MR MF MB ML' MB' ML

Synthesized Algorithm (Letter 'x')

CU MF MD' MF' MD MF MU MF' MB' MU' MB

Note that center cubes would normally not be used for displaying *full-size* letters. This would be done using *all* 16 cubies and would not be limited to 4 cubies only. A normal 4x4x4 Dot matrix Cube would then use dot patterns on corners, edges and centers. So, this is for demo only.

Cube Synthesizer 4C

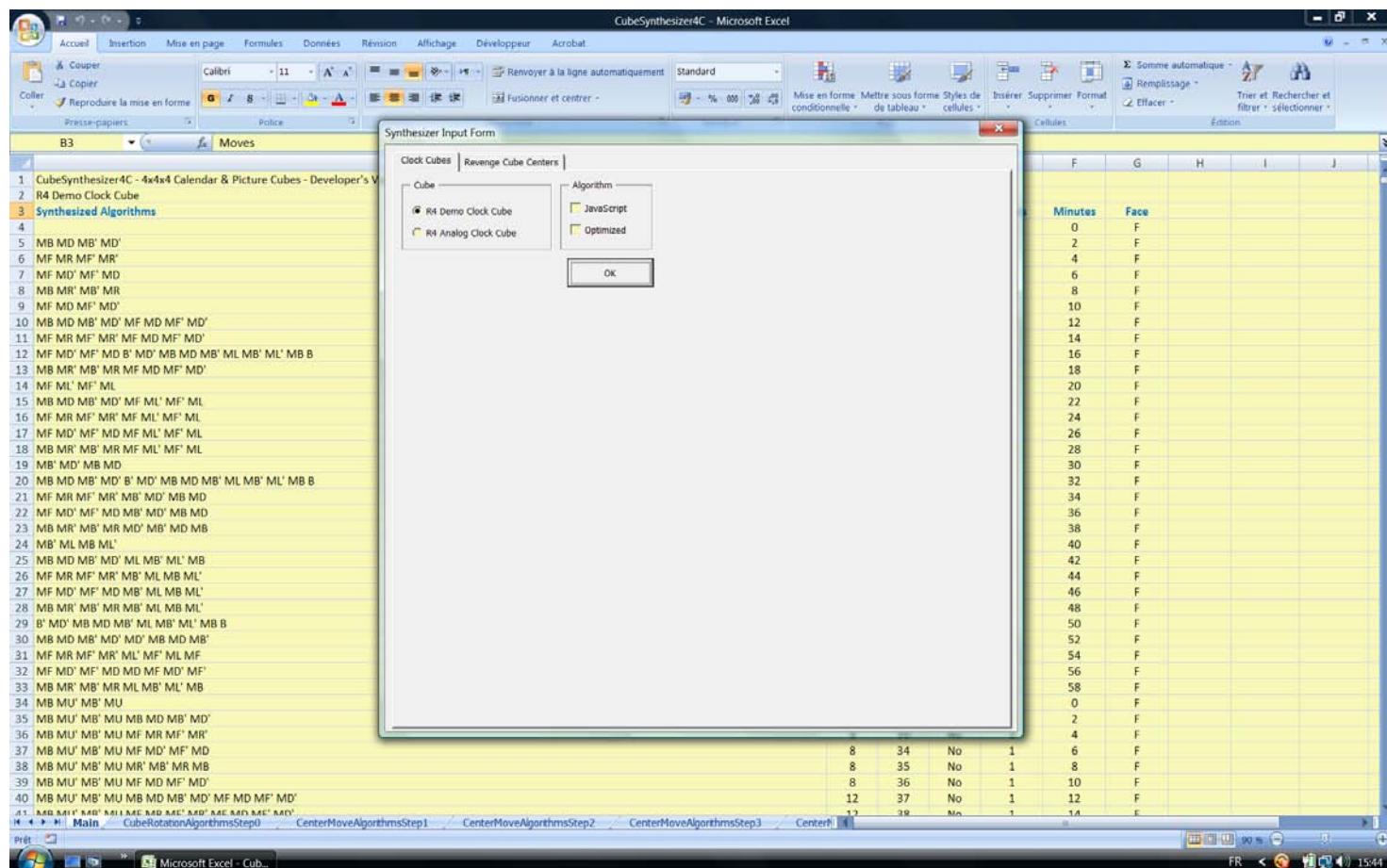
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Cube Synthesizers

Example #3: Clock Cube (Demo)

Synthesizer Input Form Example



This example shows how to use an Input Form for synthesizing algorithms. We can see that the R4 Demo Clock Cube has been selected. Note that by unchecking the 'Optimized' CheckBox, *un-optimized* algorithms are displayed. This can be used for speeding the display of algorithms because in this case, Synthesizer routines are executed only once per algorithm. Otherwise, execution time would be 24 times longer...but at least 10% of synthesized algorithms would be shorter.

Examples of [Hours Minutes] on Center Cubes

R4 Clock Cube (Demo)

Hours

2 2

Minutes

2 4

Hours

6 3

Minutes

3 6

Hours

0 0

Minutes

0 0

Hours

1 1

Minutes

1 2

Hours

7 4

Minutes

4 8

Hours

9 5

Minutes

5 8

Texture

Virtual Cube

Hours

0 0

Minutes

0 0

Hours

1 1

Minutes

1 2

Virtual Cube

R4 Clock Cube (Demo) – Examples

Virtual Cube (15:40) – Front Face

Hours

1 5

Minutes

4 0

Virtual Cube (10:24) – Up Face

Hours

1 0

Minutes

2 4

Synthesized Algorithm (15:40)

MB' ML MB ML' MF' MU' MF MU2 MF' MU' MF

Synthesized Algorithm (10:24)

CR' ML MF ML' MR' MF' MR

The cube can display the time of the day from 00:00 up to 23:58 in 2-minute steps *on any face*.

Note that *all* 16 cubies would normally be used for a fully designed Clock & Calendar Cube. The design would then not be limited to the 4 center cubies. So, this is for demo only.

Cube Synthesizer 4C

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Cube Synthesizers

R4 Cube Rotation Algorithms (Check: **done**)

Step 0 – R4 Cube Rotation Algorithms: From F/R/U/L/D/B to F [N]					
To F [N]		From F			
	Orientation		Orientation	Algorithm	Moves
	N		N	No move	0
	N		E	CF'	0
	N		S	CF2	0
	N		W	CF	0
To F [N]		From R			
	Orientation		Orientation	Algorithm	Moves
	N		N	CU	0
	N		E	CF' CR'	0
	N		S	CU' CR2	0
	N		W	CF CR	0
To F [N]		From U			
	Orientation		Orientation	Algorithm	Moves
	N		N	CR'	0
	N		E	CF' CU'	0
	N		S	CR CU2	0
	N		W	CF CU	0
To F [N]		From L			
	Orientation		Orientation	Algorithm	Moves
	N		N	CU'	0
	N		E	CF' CR	0
	N		S	CF2 CU	0
	N		W	CF CR'	0
To F [N]		From D			
	Orientation		Orientation	Algorithm	Moves
	N		N	CR	0
	N		E	CF' CU	0
	N		S	CF2 CR'	0
	N		W	CF CU'	0
To F [N]		From B			
	Orientation		Orientation	Algorithm	Moves
	N		N	CU2	0
	N		E	CF CU2	0
	N		S	CR2	0
	N		W	CF' CU2	0

R4 Center Move Algorithms – Set 0 (Check: **done**)

Front face center cubies other than the origin and destination center cubies **do not** move.

Right face center cubies **do not** move, therefore algorithms of Set 0 are longer than those of Set 1.

Algorithms have been selected to be the shortest for displaying 3-, 4- or 6-dot patterns on a 4x4x4 cube.

Algorithm Set 0 – Step 1 – R4 Center Move: From F/R/U/L/D/B to F [CTL, N]						
To F [CTL, N]		From F		Algorithms	Dots	Moves
Location	Orientation	Location	Orientation			
CTL	N	CTL	N	No move		0
CTL	N	CTR	E	MR' MU' MF' MU MF MR MF MR' MF' MR	4	10
CTL	N	CBR	S	MR' ML' MB2 ML MB2 MR	4	6
CTL	N	CBL	W	MD' ML' MB' ML MB MD	4	6
To F [CTL, N]		From R		Algorithms	Dots	Moves
Location	Orientation	Location	Orientation			
CTL	N	CTL	N	MF' MU' MF MU	6	4
CTL	N	CTR	E	ML' MB ML MB'	6	4
CTL	N	CBR	S	MU MB2 MU' MB2	6	4
CTL	N	CBL	W	ML MF ML' MF'	6	4
To F [CTL, N]		From U		Algorithms	Dots	Moves
Location	Orientation	Location	Orientation			
CTL	N	CTL	N	MB2 ML' MB2 ML	6	4
CTL	N	CTR	E	MU' MF MR2 MF' MR2 MU	6	6
CTL	N	CBR	S	ML MF2 ML' MF2	6	4
CTL	N	CBL	W	MU MB ML2 MB' ML2 MU'	6	6
To F [CTL, N]		From L		Algorithms	Dots	Moves
Location	Orientation	Location	Orientation			
CTL	N	CTL	N	MB D2 MB' MU MB D2 MB' MU'	3	8
CTL	N	CTR	E	L' MB D2 MB' MU MB D2 MB' MU' L	3	10
CTL	N	CBR	S	L2 MB D2 MB' MU MB D2 MB' MU' L2	3	10
CTL	N	CBL	W	L MB D2 MB' MU MB D2 MB' MU' L'	3	10
To F [CTL, N]		From D		Algorithms	Dots	Moves
Location	Orientation	Location	Orientation			
CTL	N	CTL	N	MF2 ML MF2 ML'	6	4
CTL	N	CTR	E	MU MB' MR2 MB MR2 MU'	6	6
CTL	N	CBR	S	ML' MB2 ML MB2	6	4
CTL	N	CBL	W	MU' MF' ML2 MF ML2 MU	6	6
To F [CTL, N]		From B		Algorithms	Dots	Moves
Location	Orientation	Location	Orientation			
CTL	N	CTL	N	B MU' MF MU MF' ML MF' ML' MF B'	4	10
CTL	N	CTR	E	MU' MF MU MF' ML MF' ML' MF	4	8
CTL	N	CBR	S	B' MU' MF MU MF' ML MF' ML' MF B	4	10
CTL	N	CBL	W	B2 MU' MF MU MF' ML MF' ML' MF B2	4	10

Algorithm Set 0 – Step 2 – R4 Center Move: From F/R/U/L/D/B to F [CTR, N]

To F [CTR, N]		From F				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CTR	N	CTL	W	ML MU MF MU' MF' ML' MF' ML MF ML'	4	10
CTR	N	CTR	N	No Move	4	0
CTR	N	CBR	E	MD MR MB MR' MB' MD'	4	6
CTR	N	CBL	S	ML MR MB2 MR' MB2 ML'	4	6
To F [CTR, N]		From R				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CTR	N	CTL	W	MR' MF MR MF'	6	4
CTR	N	CTR	N	MB MU' MB' MU	6	4
CTR	N	CBR	E	MR MB MR' MB'	6	4
CTR	N	CBL	S	MU MF2 MU' MF2	6	4
To F [CTR, N]		From U				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CTR	N	CTL	W	MU MF' ML2 MF ML2 MU'	6	6
CTR	N	CTR	N	MB2 MR MB2 MR'	6	4
CTR	N	CBR	E	MU' MB' MR2 MB MR2 MU	6	6
CTR	N	CBL	S	MR' MF2 MR MF2	6	4
To F [CTR, N]		From L				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CTR	N	CTL	W	L MF' D2 MF MU MF' D2 MF MU' L'	3	10
CTR	N	CTR	N	MF' D2 MF MU MF' D2 MF MU'	3	8
CTR	N	CBR	E	L' MF' D2 MF MU MF' D2 MF MU' L	3	10
CTR	N	CBL	S	L2 MF' D2 MF MU MF' D2 MF MU' L2	3	10
To F [CTR, N]		From D				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CTR	N	CTL	W	MU' MB ML2 MB' ML2 MU	6	6
CTR	N	CTR	N	MF2 MR' MF2 MR	6	4
CTR	N	CBR	E	MU MF MR2 MF' MR2 MU'	6	6
CTR	N	CBL	S	MR MB2 MR' MB2	6	4
To F [CTR, N]		From B				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CTR	N	CTL	W	MU MF' MU' MF MR' MF MR MF'	4	8
CTR	N	CTR	N	B' MU MF' MU' MF MR' MF MR MF' B	4	10
CTR	N	CBR	E	B2 MU MF' MU' MF MR' MF MR MF' B2	4	10
CTR	N	CBL	S	B MU MF' MU' MF MR' MF MR MF' B'	4	10

Algorithm Set 0 – Step 3 – R4 Center Move: From F/R/U/L/D/B to F [CBR, N]

To F [CBR, N]		From F				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CBR	N	CTL	S	ML MR MF2 MR' MF2 ML'	4	6
CBR	N	CTR	W	MU MR MF MR' MF' MU'	4	6
CBR	N	CBR	N	No Move		0
CBR	N	CBL	E	ML MD MB MD' MB' ML' MB' ML MB ML'	4	10
To F [CBR, N]		From R				
Location	Orientation	Location	Orientation	Algorithms		Moves
CBR	N	CTL	S	MD' MF2 MD MF2	6	4
CBR	N	CTR	W	MR' MB' MR MB	6	4
CBR	N	CBR	N	MB MD MB' MD'	6	4
CBR	N	CBL	E	MR MF' MR' MF	6	4
To F [CBR, N]		From U				
Location	Orientation	Location	Orientation	Algorithms		Moves
CBR	N	CTL	S	MR' MB2 MR MB2	6	4
CBR	N	CTR	W	MD' MF' MR2 MF MR2 MD	6	6
CBR	N	CBR	N	MF2 MR MF2 MR'	6	4
CBR	N	CBL	E	MD MB' ML2 MB ML2 MD'	6	6
To F [CBR, N]		From L				
Location	Orientation	Location	Orientation	Algorithms		Moves
CBR	N	CTL	S	L2 MF' D2 MF MD' MF' D2 MF MD L2	3	10
CBR	N	CTR	W	L MF' D2 MF MD' MF' D2 MF MD L'	3	10
CBR	N	CBR	N	MF' D2 MF MD' MF' D2 MF MD	3	8
CBR	N	CBL	E	L' MF' D2 MF MD' MF' D2 MF MD L	3	10
To F [CBR, N]		From D				
Location	Orientation	Location	Orientation	Algorithms		Moves
CBR	N	CTL	S	MR MF2 MR' MF2	6	4
CBR	N	CTR	W	MD MB MR2 MB' MR2 MD'	6	6
CBR	N	CBR	N	MB2 MR' MB2 MR	6	4
CBR	N	CBL	E	MD' MF ML2 MF' ML2 MD	6	6
To F [CBR, N]		From B				
Location	Orientation	Location	Orientation	Algorithms		Moves
CBR	N	CTL	S	B' MD' MF MD MF' MR MF' MR' MF B	4	10
CBR	N	CTR	W	B2 MD' MF MD MF' MR MF' MR' MF B2	4	10
CBR	N	CBR	N	B MD' MF MD MF' MR MF' MR' MF B'	4	10
CBR	N	CBL	E	MD' MF MD MF' MR MF' MR' MF	4	8

Algorithm Set 0 – Step 4 – R4 Center Move: From F/R/U/L/D/B to F [CBL, N]

To F [CBL, N]		From F				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CBL	N	CTL	E	MU' ML' MF' ML MF MU	4	6
CBL	N	CTR	S	MR' ML' MF2 ML MF2 MR	4	6
CBL	N	CBR	W	MR MD MF MD' MF' MR' MF' MR MF MR'	4	10
CBL	N	CBL	N	No move		0
To F [CBL, N]		From R				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CBL	N	CTL	E	ML' MF' ML MF	6	4
CBL	N	CTR	S	MD' MB2 MD MB2	6	4
CBL	N	CBR	W	ML MB' ML' MB	6	4
CBL	N	CBL	N	MF MD MF' MD'	6	4
To F [CBL, N]		From U				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CBL	N	CTL	E	MD MF ML2 MF' ML2 MD'	6	6
CBL	N	CTR	S	ML MB2 ML' MB2	6	4
CBL	N	CBR	W	MD' MB MR2 MB' MR2 MD	6	6
CBL	N	CBL	N	MF2 ML' MF2 ML	6	4
To F [CBL, N]		From L				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CBL	N	CTL	E	L' MB D2 MB' MD' MB D2 MB' MD L	3	10
CBL	N	CTR	S	L2 MB D2 MB' MD' MB D2 MB' MD L2	3	10
CBL	N	CBR	W	L MB D2 MB' MD' MB D2 MB' MD L'	3	10
CBL	N	CBL	N	MB D2 MB' MD' MB D2 MB' MD	3	8
To F [CBL, N]		From D				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CBL	N	CTL	E	MD' MB' ML2 MB ML2 MD	6	6
CBL	N	CTR	S	ML' MF2 ML MF2	6	4
CBL	N	CBR	W	MD MF' MR2 MF MR2 MD'	6	6
CBL	N	CBL	N	MB2 ML MB2 ML'	6	4
To F [CBL, N]		From B				
Location	Orientation	Location	Orientation	Algorithms	Dots	Moves
CBL	N	CTL	E	B2 MD' MB MD MB' ML MB' ML' MB B2	4	10
CBL	N	CTR	S	B MD' MB MD MB' ML MB' ML' MB B'	4	10
CBL	N	CBR	W	MD' MB MD MB' ML MB' ML' MB	4	8
CBL	N	CBL	N	B' MD' MB MD MB' ML MB' ML' MB B	4	10

R4 Center Move Algorithms – Set 1 (Check: **done**)

Front face center cubies other than the origin and destination center cubies **do not** move.

Right face center cubies **may** move, therefore algorithms of Set 1 are shorter than those of Set 0.

Algorithm Set 1 – Step 1 – R4 Center Move: From F/R/U/L/D/B to F [CTL, N]					
To F [CTL, N]		From F			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTL	N	CTL	N	No move	0
CTL	N	CTR	E	MR' MU' MF' MU MF MR	6
CTL	N	CBR	S	MR' ML' MB2 ML MB2 MR	6
CTL	N	CBL	W	MD' ML' MB' ML MB MD	6
To F [CTL, N]		From R			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTL	N	CTL	N	MF' MU' MF MU	4
CTL	N	CTR	E	ML' MB ML MB'	4
CTL	N	CBR	S	MU MB2 MU' MB2	4
CTL	N	CBL	W	ML MF ML' MF'	4
To F [CTL, N]		From U			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTL	N	CTL	N	MB2 ML' MB2 ML	4
CTL	N	CTR	E	MU MB MU' MB'	4
CTL	N	CBR	S	ML MF2 ML' MF2	4
CTL	N	CBL	W	MU' MF MU MF'	4
To F [CTL, N]		From L			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTL	N	CTL	N	MB' MU MB MU'	4
CTL	N	CTR	E	ML MF' ML' MF	4
CTL	N	CBR	S	MU' MF2 MU MF2	4
CTL	N	CBL	W	ML' MB' ML MB	4
To F [CTL, N]		From D			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTL	N	CTL	N	MF2 ML MF2 ML'	4
CTL	N	CTR	E	MU' MF' MU MF	4
CTL	N	CBR	S	ML' MB2 ML MB2	4
CTL	N	CBL	W	MU MB' MU' MB	4
To F [CTL, N]		From B			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTL	N	CTL	N	B MU' MF MU MF' ML MF' ML' MF B'	10
CTL	N	CTR	E	MU' MF MU MF' ML MF' ML' MF	8
CTL	N	CBR	S	B' MU' MF MU MF' ML MF' ML' MF B	10
CTL	N	CBL	W	B2 MU' MF MU MF' ML MF' ML' MF B2	10

Algorithm Set 1 – Step 2 – R4 Center Move: From F/R/U/L/D/B to F [CTR, N]					
To F [CTR, N]		From F			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTR	N	CTL	W	ML MU MF MU' MF' ML'	6
CTR	N	CTR	N	No Move	0
CTR	N	CBR	E	MD MR MB MR' MB' MD'	6
CTR	N	CBL	S	ML MR MB2 MR' MB2 ML'	6
To F [CTR, N]		From R			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTR	N	CTL	W	MR' MF MR MF'	4
CTR	N	CTR	N	MB MU' MB' MU	4
CTR	N	CBR	E	MR MB MR' MB'	4
CTR	N	CBL	S	MU MF2 MU' MF2	4
To F [CTR, N]		From U			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTR	N	CTL	W	MU' MB' MU MB	4
CTR	N	CTR	N	MB2 MR MB2 MR'	4
CTR	N	CBR	E	MU MF' MU' MF	4
CTR	N	CBL	S	MR' MF2 MR MF2	4
To F [CTR, N]		From L			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTR	N	CTL	W	MR MB' MR' MB	4
CTR	N	CTR	N	MF MU MF' MU'	4
CTR	N	CBR	E	MR' MF' MR MF	4
CTR	N	CBL	S	MU' MB2 MU MB2	4
To F [CTR, N]		From D			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTR	N	CTL	W	MU MF MU' MF'	4
CTR	N	CTR	N	MF2 MR' MF2 MR	4
CTR	N	CBR	E	MU' MB MU MB'	4
CTR	N	CBL	S	MR MB2 MR' MB2	4
To F [CTR, N]		From B			
Location	Orientation	Location	Orientation	Algorithms	Moves
CTR	N	CTL	W	MU MF' MU' MF MR' MF MR MF'	8
CTR	N	CTR	N	B' MU MF' MU' MF MR' MF MR MF' B	10
CTR	N	CBR	E	B2 MU MF' MU' MF MR' MF MR MF' B2	10
CTR	N	CBL	S	B MU MF' MU' MF MR' MF MR MF' B'	10

Algorithm Set 1 – Step 3 – R4 Center Move: From F/R/U/L/D/B to F [CBR, N]

To F [CBR, N]		From F			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBR	N	CTL	S	ML MR MF2 MR' MF2 ML'	6
CBR	N	CTR	W	MU MR MF MR' MF' MU'	6
CBR	N	CBR	N	No Move	0
CBR	N	CBL	E	ML MD MB MD' MB' ML'	6
To F [CBR, N]		From R			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBR	N	CTL	S	MD' MF2 MD MF2	4
CBR	N	CTR	W	MR' MB' MR MB	4
CBR	N	CBR	N	MB MD MB' MD'	4
CBR	N	CBL	E	MR MF' MR' MF	4
To F [CBR, N]		From U			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBR	N	CTL	S	MR' MB2 MR MB2	4
CBR	N	CTR	W	MD MB' MD' MB	4
CBR	N	CBR	N	MF2 MR MF2 MR'	4
CBR	N	CBL	E	MD' MF' MD MF	4
To F [CBR, N]		From L			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBR	N	CTL	S	MD MB2 MD' MB2	4
CBR	N	CTR	W	MR MF MR' MF'	4
CBR	N	CBR	N	MF MD' MF' MD	4
CBR	N	CBL	E	MR' MB MR MB'	4
To F [CBR, N]		From D			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBR	N	CTL	S	MR MF2 MR' MF2	4
CBR	N	CTR	W	MD' MF MD MF'	4
CBR	N	CBR	N	MB2 MR' MB2 MR	4
CBR	N	CBL	E	MD MB MD' MB'	4
To F [CBR, N]		From B			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBR	N	CTL	S	B' MD' MF MD MF' MR MF' MR' MF B	10
CBR	N	CTR	W	B2 MD' MF MD MF' MR MF' MR' MF B2	10
CBR	N	CBR	N	B MD' MF MD MF' MR MF' MR' MF B'	10
CBR	N	CBL	E	MD' MF MD MF' MR MF' MR' MF	8

Algorithm Set 1 – Step 4 – R4 Center Move: From F/R/U/L/D/B to F [CBL, N]

To F [CBL, N]		From F			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBL	N	CTL	E	MU' ML' MF' ML MF MU	6
CBL	N	CTR	S	MR' ML' MF2 ML MF2 MR	6
CBL	N	CBR	W	MR MD MF MD' MF' MR'	6
CBL	N	CBL	N	No move	0
To F [CBL, N]		From R			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBL	N	CTL	E	ML' MF' ML MF	4
CBL	N	CTR	S	MD' MB2 MD MB2	4
CBL	N	CBR	W	ML MB' ML' MB	4
CBL	N	CBL	N	MF MD MF' MD'	4
To F [CBL, N]		From U			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBL	N	CTL	E	MD' MB MD MB'	4
CBL	N	CTR	S	ML MB2 ML' MB2	4
CBL	N	CBR	W	MD MF MD' MF'	4
CBL	N	CBL	N	MF2 ML' MF2 ML	4
To F [CBL, N]		From L			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBL	N	CTL	E	ML MB ML' MB'	4
CBL	N	CTR	S	MD MF2 MD' MF2	4
CBL	N	CBR	W	ML' MF ML MF'	4
CBL	N	CBL	N	MB' MD' MB MD	4
To F [CBL, N]		From D			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBL	N	CTL	E	MD MF' MD' MF	4
CBL	N	CTR	S	ML' MF2 ML MF2	4
CBL	N	CBR	W	MD' MB' MD MB	4
CBL	N	CBL	N	MB2 ML MB2 ML'	4
To F [CBL, N]		From B			
Location	Orientation	Location	Orientation	Algorithms	Moves
CBL	N	CTL	E	B2 MD' MB MD MB' ML MB' ML' MB B2	10
CBL	N	CTR	S	B MD' MB MD MB' ML MB' ML' MB B'	10
CBL	N	CBR	W	MD' MB MD MB' ML MB' ML' MB	8
CBL	N	CBL	N	B' MD' MB MD MB' ML MB' ML' MB B	10

R4 Cube Rotation – Center Cubes States

Step 0 (Check: done)

Cube Rotation – Center Cubes States – Step 0: From F [E] To F [N]											
		6	8					0	0		
		5	7					0	0		
10	12	2	4	18	20	0	0	0	0	0	0
9	11	1	3	17	19	0	0	0	0	0	0
		14	16	23	21			0	0	0	0
		13	15	24	22			0	0	0	0
Cube Rotation – Center Cubes States – Step 0: From F [S] To F [N]											
		20	19					0	0		
		18	17					0	0		
8	7	4	3	16	15	0	0	0	0	0	0
6	5	2	1	14	13	0	0	0	0	0	0
		12	11	24	23			0	0	0	0
		10	9	22	21			0	0	0	0
Cube Rotation – Center Cubes States – Step 0: From F [W] To F [N]											
		15	13					0	0		
		16	14					0	0		
19	17	3	1	11	9	0	0	0	0	0	0
20	18	4	2	12	10	0	0	0	0	0	0
		7	5	22	24			0	0	0	0
		8	6	21	23			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From R [N] To F [N]

		11	9					0	0		
		12	10					0	0		
1	2	5	6	21	22	0	0	0	0	0	0
3	4	7	8	23	24	0	0	0	0	0	0
		18	20	13	14			0	0	0	0
		17	19	15	16			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From R [E] To F [N]

		22	24					0	0		
		21	23					0	0		
9	10	6	8	20	19	0	0	0	0	0	0
11	12	5	7	18	17	0	0	0	0	0	0
		2	4	15	13			0	0	0	0
		1	3	16	14			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From R [S] To F [N]

		19	17					0	0		
		20	18					0	0		
24	23	8	7	4	3	0	0	0	0	0	0
22	21	6	5	2	1	0	0	0	0	0	0
		10	12	16	15			0	0	0	0
		9	11	14	13			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From R [W] To F [N]

		3	1					0	0		
		4	2					0	0		
17	18	7	5	12	11	0	0	0	0	0	0
19	20	8	6	10	9	0	0	0	0	0	0
		23	21	14	16			0	0	0	0
		24	22	13	15			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From U [N] To F [N]

		24	23					0	0		
		22	21					0	0		
15	13	9	10	6	8	0	0	0	0	0	0
16	14	11	12	5	7	0	0	0	0	0	0
		1	2	20	19			0	0	0	0
		3	4	18	17			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From U [E] To F [N]

		8	7					0	0		
		6	5					0	0		
23	21	10	12	2	4	0	0	0	0	0	0
24	22	9	11	1	3	0	0	0	0	0	0
		13	14	18	20			0	0	0	0
		15	16	17	19			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From U [S] To F [N]

		4	3					0	0		
		2	1					0	0		
7	5	12	11	14	16	0	0	0	0	0	0
8	6	10	9	13	15	0	0	0	0	0	0
		21	22	17	18			0	0	0	0
		23	24	19	20			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From U [W] To F [N]

		16	15					0	0		
		14	13					0	0		
3	1	11	9	22	24	0	0	0	0	0	0
4	2	12	10	21	23	0	0	0	0	0	0
		5	6	19	17			0	0	0	0
		7	8	20	18			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From L [N] To F [N]

		10	12					0	0		
		9	11					0	0		
21	22	13	14	1	2	0	0	0	0	0	0
23	24	15	16	3	4	0	0	0	0	0	0
		19	17	5	6			0	0	0	0
		20	18	7	8			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From L [E] To F [N]

		2	4					0	0		
		1	3					0	0		
12	11	14	16	17	18	0	0	0	0	0	0
10	9	13	15	19	20	0	0	0	0	0	0
		22	24	7	5			0	0	0	0
		21	23	8	6			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From L [S] To F [N]

		18	20					0	0		
		17	19					0	0		
4	3	16	15	24	23	0	0	0	0	0	0
2	1	14	13	22	21	0	0	0	0	0	0
		11	9	8	7			0	0	0	0
		12	10	6	5			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From L [W] To F [N]

		23	21					0	0		
		24	22					0	0		
20	19	15	13	9	10	0	0	0	0	0	0
18	17	16	14	11	12	0	0	0	0	0	0
		3	1	6	8			0	0	0	0
		4	2	5	7			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From D [N] To F [N]

		1	2					0	0		
		3	4					0	0		
14	16	17	18	7	5	0	0	0	0	0	0
13	15	19	20	8	6	0	0	0	0	0	0
		24	23	12	11			0	0	0	0
		22	21	10	9			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From D [E] To F [N]

		5	6					0	0		
		7	8					0	0		
2	4	18	20	23	21	0	0	0	0	0	0
1	3	17	19	24	22	0	0	0	0	0	0
		16	15	10	12			0	0	0	0
		14	13	9	11			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From D [S] To F [N]

		21	22					0	0		
		23	24					0	0		
6	8	20	19	15	13	0	0	0	0	0	0
5	7	18	17	16	14	0	0	0	0	0	0
		4	3	9	10			0	0	0	0
		2	1	11	12			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From D [W] To F [N]

		13	14					0	0		
		15	16					0	0		
22	24	19	17	3	1	0	0	0	0	0	0
21	23	20	18	4	2	0	0	0	0	0	0
		8	7	11	9			0	0	0	0
		6	5	12	10			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From B [N] To F [N]

		12	11					0	0		
		10	9					0	0		
5	6	21	22	13	14	0	0	0	0	0	0
7	8	23	24	15	16	0	0	0	0	0	0
		20	19	1	2			0	0	0	0
		18	17	3	4			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From B [E] To F [N]

		14	16					0	0		
		13	15					0	0		
11	9	22	24	19	17	0	0	0	0	0	0
12	10	21	23	20	18	0	0	0	0	0	0
		6	8	3	1			0	0	0	0
		5	7	4	2			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From B [S] To F [N]

		17	18					0	0		
		19	20					0	0		
16	15	24	23	8	7	0	0	0	0	0	0
14	13	22	21	6	5	0	0	0	0	0	0
		9	10	4	3			0	0	0	0
		11	12	2	1			0	0	0	0

Cube Rotation – Center Cubes States – Step 0: From B [W] To F [N]

		7	5					0	0		
		8	6					0	0		
18	20	23	21	10	12	0	0	0	0	0	0
17	19	24	22	9	11	0	0	0	0	0	0
		15	13	2	4			0	0	0	0
		16	14	1	3			0	0	0	0

Center Cubes States – Algorithm Set 0

Step 1 (Check: done)

Algorithm Set 0 – Center Cubes States – Step 1: From F [CTR, E] To F [CTL, N]											
		9	10					0	0		
		11	22					0	0		
13	14	2	18	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	1	12	21			0	0	0	0
		19	20	23	24			0	0	0	0
Algorithm Set 0 – Center Cubes States – Step 1: From F [CBR, S] To F [CTL, N]											
		1	10					0	0		
		11	12					0	0		
13	14	4	2	5	6	0	0	0	0	0	0
15	16	3	9	7	8	0	0	0	0	0	0
		17	18	21	23			0	0	0	0
		22	20	19	24			0	0	0	0
Algorithm Set 0 – Center Cubes States – Step 1: From F [CBL, W] To F [CTL, N]											
		1	10					0	0		
		11	12					0	0		
13	14	3	2	5	6	0	0	0	0	0	0
15	16	9	4	7	8	0	0	0	0	0	0
		17	18	21	24			0	0	0	0
		22	20	23	19			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From R [CTL, N] To F [CTL, N]

		9	10					0	0		
		11	22					0	0		
13	12	5	2	18	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	1	21	14			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From R [CTR, E] To F [CTL, N]

		1	10					0	0		
		11	12					0	0		
19	14	6	2	5	9	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	13			0	0	0	0
		22	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From R [CBR, S] To F [CTL, N]

		9	10					0	0		
		11	12					0	0		
1	14	8	2	5	22	0	0	0	0	0	0
6	16	3	4	7	13	0	0	0	0	0	0
		17	18	21	15			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From R [CBL, W] To F [CTL, N]

		9	10					0	0		
		22	12					0	0		
13	14	7	2	5	6	0	0	0	0	0	0
15	11	3	4	17	8	0	0	0	0	0	0
		1	18	21	16			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From U [CTL, N] To F [CTL, N]

		20	22					0	0		
		11	12					0	0		
13	14	9	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	19			0	0	0	0
		10	1	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From U [CTR, E] To F [CTL, N]

		9	18					0	0		
		11	22					0	0		
13	14	10	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	1	21	20			0	0	0	0
		19	12	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From U [CBR, S] To F [CTL, N]

		9	10					0	0		
		22	17					0	0		
13	14	12	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		1	11	21	18			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From U [CBL, W] To F [CTL, N]

		22	10					0	0		
		19	12					0	0		
13	14	11	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		9	18	21	17			0	0	0	0
		1	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From L [CTL, N] To F [CTL, N]

		9	10					0	0		
		11	12					0	0		
18	14	13	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	1	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From L [CTR, E] To F [CTL, N]

		9	10					0	0		
		11	12					0	0		
13	18	14	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	1	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From L [CBR, S] To F [CTL, N]

		9	10					0	0		
		11	12					0	0		
13	14	16	2	5	6	0	0	0	0	0	0
15	18	3	4	7	8	0	0	0	0	0	0
		17	1	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From L [CBL, W] To F [CTL, N]

		9	10					0	0		
		11	12					0	0		
13	14	15	2	5	6	0	0	0	0	0	0
18	16	3	4	7	8	0	0	0	0	0	0
		17	1	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From D [CTL, N] To F [CTL, N]

		9	10					0	0		
		18	1					0	0		
13	14	17	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		12	22	21	11			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From D [CTR, E] To F [CTL, N]

		9	1					0	0		
		11	20					0	0		
13	14	18	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	10	21	12			0	0	0	0
		19	22	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From D [CBR, S] To F [CTL, N]

		1	19					0	0		
		11	12					0	0		
13	14	20	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	10			0	0	0	0
		22	9	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From D [CBL, W] To F [CTL, N]

		17	10					0	0		
		1	12					0	0		
13	14	19	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		22	18	21	9			0	0	0	0
		11	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From B [CTL, N] To F [CTL, N]

		9	10					0	0		
		17	12					0	0		
13	14	21	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		11	18	1	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From B [CTR, E] To F [CTL, N]

		9	10					0	0		
		17	12					0	0		
13	14	22	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		11	18	21	1			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From B [CBR, S] To F [CTL, N]

		9	10					0	0		
		17	12					0	0		
13	14	24	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		11	18	21	22			0	0	0	0
		19	20	23	1			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 1: From B [CBL, W] To F [CTL, N]

		9	10					0	0		
		17	12					0	0		
13	14	23	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		11	18	21	22			0	0	0	0
		19	20	1	24			0	0	0	0

Step 2 (Check: done)

Algorithm Set 0 – Center Cubes States – Step 2: From F [CTL, W] To F [CTR, N]											
		9	10					0	0		
		21	12					0	0		
13	14	17	1	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		2	18	22	11			0	0	0	0
		19	20	23	24			0	0	0	0
Algorithm Set 0 – Center Cubes States – Step 2: From F [CBR, E] To F [CTR, N]											
		9	2					0	0		
		11	12					0	0		
13	14	1	4	5	6	0	0	0	0	0	0
15	16	3	10	7	8	0	0	0	0	0	0
		17	18	23	22			0	0	0	0
		19	21	20	24			0	0	0	0
Algorithm Set 0 – Center Cubes States – Step 2: From F [CBL, S] To F [CTR, N]											
		9	2					0	0		
		11	12					0	0		
13	14	1	3	5	6	0	0	0	0	0	0
15	16	10	4	7	8	0	0	0	0	0	0
		17	18	24	22			0	0	0	0
		19	21	23	20			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From R [CTL, W] To F [CTR, N]

		9	10					0	0		
		11	21					0	0		
13	12	1	5	18	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	2	14	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From R [CTR, N] To F [CTR, N]

		9	21					0	0		
		11	12					0	0		
10	14	1	6	5	20	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	13	22			0	0	0	0
		19	2	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From R [CBR, E] To F [CTR, N]

		9	2					0	0		
		11	12					0	0		
13	14	1	8	5	6	0	0	0	0	0	0
20	16	3	4	7	10	0	0	0	0	0	0
		17	18	15	22			0	0	0	0
		19	21	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From R [CBL, S] To F [CTR, N]

		9	10					0	0		
		11	12					0	0		
13	2	1	7	21	6	0	0	0	0	0	0
15	5	3	4	14	8	0	0	0	0	0	0
		17	18	16	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From U [CTL, W] To F [CTR, N]

		17	10					0	0		
		21	12					0	0		
13	14	1	9	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		2	18	19	22			0	0	0	0
		11	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From U [CTR, N] To F [CTR, N]

		21	19					0	0		
		11	12					0	0		
13	14	1	10	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	20	22			0	0	0	0
		2	9	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From U [CBR, E] To F [CTR, N]

		9	21					0	0		
		11	20					0	0		
13	14	1	12	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	10	18	22			0	0	0	0
		19	2	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From U [CBL, S] To F [CTR, N]

		9	10					0	0		
		18	21					0	0		
13	14	1	11	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		12	2	17	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From L [CTL, W] To F [CTR, N]

		9	10					0	0		
		11	12					0	0		
20	14	1	13	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	2	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From L [CTR, N] To F [CTR, N]

		9	10					0	0		
		11	12					0	0		
13	20	1	14	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	2	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From L [CBR, E] To F [CTR, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	16	5	6	0	0	0	0	0	0
15	20	3	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	2	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From L [CBL, S] To F [CTR, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	15	5	6	0	0	0	0	0	0
20	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	2	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From D [CTL, W] To F [CTR, N]

		2	10					0	0		
		19	12					0	0		
13	14	1	17	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		9	18	11	22			0	0	0	0
		21	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From D [CTR, N] To F [CTR, N]

		9	10					0	0		
		2	17					0	0		
13	14	1	18	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		21	11	12	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From D [CBR, E] To F [CTR, N]

		9	18					0	0		
		11	2					0	0		
13	14	1	20	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	21	10	22			0	0	0	0
		19	12	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From D [CBL, S] To F [CTR, N]

		20	2					0	0		
		11	12					0	0		
13	14	1	19	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	9	22			0	0	0	0
		10	21	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From B [CTL, W] To F [CTR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	21	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	12	2	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From B [CTR, N] To F [CTR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	22	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	12	21	2			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From B [CBR, E] To F [CTR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	24	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	12	21	22			0	0	0	0
		19	20	23	2			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 2: From B [CBL, S] To F [CTR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	23	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	12	21	22			0	0	0	0
		19	20	2	24			0	0	0	0

Step 3 (Check: done)

Algorithm Set 0 – Center Cubes States – Step 3: From F [CTL, S] To F [CBR, N]

		9	10					0	0		
		11	4					0	0		
13	14	12	2	5	6	0	0	0	0	0	0
15	16	3	1	7	8	0	0	0	0	0	0
		17	23	21	18			0	0	0	0
		19	20	22	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From F [CTR, W] To F [CBR, N]

		9	10					0	0		
		11	4					0	0		
13	14	1	12	5	6	0	0	0	0	0	0
15	16	3	2	7	8	0	0	0	0	0	0
		17	23	18	22			0	0	0	0
		19	20	21	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From F [CBL, E] To F [CBR, N]

		23	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	19	3	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		4	20	24	9			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From R [CTL, S] To F [CBR, N]

		9	10					0	0		
		11	12					0	0		
13	7	1	2	16	6	0	0	0	0	0	0
15	4	3	5	23	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	14	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From R [CTR, W] To F [CBR, N]

		9	23					0	0		
		11	12					0	0		
10	14	1	2	5	20	0	0	0	0	0	0
15	16	3	6	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	4	13	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From R [CBR, N] To F [CBR, N]

		23	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
9	16	3	8	7	19	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		4	20	15	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From R [CBL, E] To F [CBR, N]

		9	10					0	0		
		11	4					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	18	3	7	12	8	0	0	0	0	0	0
		17	23	21	22			0	0	0	0
		19	20	16	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From U [CTL, S] To F [CBR, N]

		20	23					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	9	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		10	4	19	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From U [CTR, W] To F [CBR, N]

		9	18					0	0		
		11	23					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	10	7	8	0	0	0	0	0	0
		17	4	21	22			0	0	0	0
		19	12	20	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From U [CBR, N] To F [CBR, N]

		9	10					0	0		
		23	17					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	12	7	8	0	0	0	0	0	0
		4	11	21	22			0	0	0	0
		19	20	18	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From U [CBL, E] To F [CBR, N]

		23	10					0	0		
		19	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	11	7	8	0	0	0	0	0	0
		9	18	21	22			0	0	0	0
		4	20	17	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From L [CTL, S] To F [CBR, N]

		9	10					0	0		
		11	12					0	0		
19	14	1	2	5	6	0	0	0	0	0	0
15	16	3	13	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		4	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From L [CTR, W] To F [CBR, N]

		9	10					0	0		
		11	12					0	0		
13	19	1	2	5	6	0	0	0	0	0	0
15	16	3	14	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		4	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From L [CBR, N] To F [CBR, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	19	3	16	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		4	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From L [CBL, E] To F [CBR, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
19	16	3	15	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		4	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From D [CTL, S] To F [CBR, N]

		9	10					0	0		
		18	4					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	17	7	8	0	0	0	0	0	0
		12	23	21	22			0	0	0	0
		19	20	11	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From D [CTR, W] To F [CBR, N]

		9	4					0	0		
		11	20					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	18	7	8	0	0	0	0	0	0
		17	10	21	22			0	0	0	0
		19	23	12	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From D [CBR, N] To F [CBR, N]

		4	19					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	20	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		23	9	10	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From D [CBL, E] To F [CBR, N]

		17	10					0	0		
		4	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	19	7	8	0	0	0	0	0	0
		23	18	21	22			0	0	0	0
		11	20	9	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From B [CTL, S] To F [CBR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	21	7	8	0	0	0	0	0	0
		17	12	4	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From B [CTR, W] To F [CBR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	22	7	8	0	0	0	0	0	0
		17	12	21	4			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From B [CBR, N] To F [CBR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	24	7	8	0	0	0	0	0	0
		17	12	21	22			0	0	0	0
		19	20	23	4			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 3: From B [CBL, E] To F [CBR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	23	7	8	0	0	0	0	0	0
		17	12	21	22			0	0	0	0
		19	20	4	24			0	0	0	0

Step 4 (Check: done)

Algorithm Set 0 – Center Cubes States – Step 4: From F [CTL, E] To F [CBL, N]											
		9	10					0	0		
		3	12					0	0		
13	14	11	2	5	6	0	0	0	0	0	0
15	16	1	4	7	8	0	0	0	0	0	0
		24	18	21	17			0	0	0	0
		19	20	23	22			0	0	0	0
Algorithm Set 0 – Center Cubes States – Step 4: From F [CTR, S] To F [CBL, N]											
		9	10					0	0		
		3	12					0	0		
13	14	1	11	5	6	0	0	0	0	0	0
15	16	2	4	7	8	0	0	0	0	0	0
		24	18	17	22			0	0	0	0
		19	20	23	21			0	0	0	0
Algorithm Set 0 – Center Cubes States – Step 4: From F [CBR, W] To F [CBL, N]											
		9	10					0	0		
		11	3					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	4	12	7	8	0	0	0	0	0	0
		17	24	21	22			0	0	0	0
		19	20	18	23			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From R [CTL, E] To F [CBL, N]

		9	10					0	0		
		3	12					0	0		
13	17	1	2	11	6	0	0	0	0	0	0
15	16	5	4	7	8	0	0	0	0	0	0
		24	18	21	22			0	0	0	0
		19	20	23	14			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From R [CTR, S] To F [CBL, N]

		9	10					0	0		
		11	12					0	0		
8	14	1	2	5	15	0	0	0	0	0	0
3	16	6	4	7	24	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	23	13			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From R [CBR, W] To F [CBL, N]

		24	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
9	16	8	4	7	19	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		3	20	23	15			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From R [CBL, N] To F [CBL, N]

		9	10					0	0		
		11	3					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	18	7	4	12	8	0	0	0	0	0	0
		17	24	21	22			0	0	0	0
		19	20	23	16			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From U [CTL, E] To F [CBL, N]

		17	10					0	0		
		24	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	9	4	7	8	0	0	0	0	0	0
		3	18	21	22			0	0	0	0
		11	20	23	19			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From U [CTR, S] To F [CBL, N]

		24	19					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	10	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		3	9	23	20			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From U [CBR, W] To F [CBL, N]

		9	24					0	0		
		11	20					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	12	4	7	8	0	0	0	0	0	0
		17	10	21	22			0	0	0	0
		19	3	23	18			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From U [CBL, N] To F [CBL, N]

		9	10					0	0		
		18	24					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	11	4	7	8	0	0	0	0	0	0
		12	3	21	22			0	0	0	0
		19	20	23	17			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From L [CTL, E] To F [CBL, N]

		9	10					0	0		
		11	12					0	0		
17	14	1	2	5	6	0	0	0	0	0	0
15	16	13	4	7	8	0	0	0	0	0	0
		3	18	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From L [CTR, S] To F [CBL, N]

		9	10					0	0		
		11	12					0	0		
13	17	1	2	5	6	0	0	0	0	0	0
15	16	14	4	7	8	0	0	0	0	0	0
		3	18	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From L [CBR, W] To F [CBL, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	17	16	4	7	8	0	0	0	0	0	0
		3	18	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From L [CBL, N] To F [CBL, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
17	16	15	4	7	8	0	0	0	0	0	0
		3	18	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From D [CTL, E] To F [CBL, N]

		3	10					0	0		
		19	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	17	4	7	8	0	0	0	0	0	0
		9	18	21	22			0	0	0	0
		24	20	23	11			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From D [CTR, S] To F [CBL, N]

		9	10					0	0		
		3	17					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	18	4	7	8	0	0	0	0	0	0
		24	11	21	22			0	0	0	0
		19	20	23	12			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From D [CBR, W] To F [CBL, N]

		9	18					0	0		
		11	3					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	20	4	7	8	0	0	0	0	0	0
		17	24	21	22			0	0	0	0
		19	12	23	10			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From D [CBL, N] To F [CBL, N]

		20	3					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	19	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		10	24	23	9			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From B [CTL, E] To F [CBL, N]

		19	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	21	4	7	8	0	0	0	0	0	0
		17	18	3	22			0	0	0	0
		9	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From B [CTR, S] To F [CBL, N]

		19	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	22	4	7	8	0	0	0	0	0	0
		17	18	21	3			0	0	0	0
		9	20	23	24			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From B [CBR, W] To F [CBL, N]

		19	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	24	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		9	20	23	3			0	0	0	0

Algorithm Set 0 – Center Cubes States – Step 4: From B [CBL, N] To F [CBL, N]

		19	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	23	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		9	20	3	24			0	0	0	0

Center Cubes States – Algorithm Set 1

Step 1 (Check: done)

Algorithm Set 1 – Center Cubes States – Step 1: From F [CTR, E] To F [CTL, N]											
		9	10					0	0		
		11	12					0	0		
13	22	2	5	1	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	14	21			0	0	0	0
		19	20	23	24			0	0	0	0
Algorithm Set 1 – Center Cubes States – Step 1: From F [CBR, S] To F [CTL, N]											
		1	10					0	0		
		11	12					0	0		
13	14	4	2	5	6	0	0	0	0	0	0
15	16	3	9	7	8	0	0	0	0	0	0
		17	18	21	23			0	0	0	0
		22	20	19	24			0	0	0	0
Algorithm Set 1 – Center Cubes States – Step 1: From F [CBL, W] To F [CTL, N]											
		1	10					0	0		
		11	12					0	0		
13	14	3	2	5	6	0	0	0	0	0	0
15	16	9	4	7	8	0	0	0	0	0	0
		17	18	21	24			0	0	0	0
		22	20	23	19			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From R [CTL, N] To F [CTL, N]

		9	10					0	0		
		11	22					0	0		
13	12	5	2	18	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	1	21	14			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From R [CTR, E] To F [CTL, N]

		1	10					0	0		
		11	12					0	0		
19	14	6	2	5	9	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	13			0	0	0	0
		22	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From R [CBR, S] To F [CTL, N]

		9	10					0	0		
		11	12					0	0		
1	14	8	2	5	22	0	0	0	0	0	0
6	16	3	4	7	13	0	0	0	0	0	0
		17	18	21	15			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From R [CBL, W] To F [CTL, N]

		9	10					0	0		
		22	12					0	0		
13	14	7	2	5	6	0	0	0	0	0	0
15	11	3	4	17	8	0	0	0	0	0	0
		1	18	21	16			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From U [CTL, N] To F [CTL, N]

		6	10					0	0		
		11	12					0	0		
22	14	9	2	5	1	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	19			0	0	0	0
		13	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From U [CTR, E] To F [CTL, N]

		9	13					0	0		
		11	12					0	0		
1	14	10	2	5	22	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	20			0	0	0	0
		19	6	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From U [CBR, S] To F [CTL, N]

		9	10					0	0		
		22	17					0	0		
13	14	12	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		1	11	21	18			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From U [CBL, W] To F [CTL, N]

		9	10					0	0		
		5	12					0	0		
13	22	11	2	1	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		14	18	21	17			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From L [CTL, N] To F [CTL, N]

		22	10					0	0		
		11	12					0	0		
19	14	13	2	5	9	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	6			0	0	0	0
		1	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From L [CTR, E] To F [CTL, N]

		9	10					0	0		
		22	12					0	0		
13	17	14	2	11	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		1	18	21	5			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From L [CBR, S] To F [CTL, N]

		9	10					0	0		
		11	12					0	0		
13	22	16	2	1	6	0	0	0	0	0	0
15	5	3	4	14	8	0	0	0	0	0	0
		17	18	21	7			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From L [CBL, W] To F [CTL, N]

		1	10					0	0		
		11	12					0	0		
13	14	15	2	5	6	0	0	0	0	0	0
9	16	3	4	7	19	0	0	0	0	0	0
		17	18	21	8			0	0	0	0
		22	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From D [CTL, N] To F [CTL, N]

		9	10					0	0		
		16	12					0	0		
13	14	17	2	5	6	0	0	0	0	0	0
15	22	3	4	1	8	0	0	0	0	0	0
		7	18	21	11			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From D [CTR, E] To F [CTL, N]

		9	10					0	0		
		11	14					0	0		
13	22	18	2	1	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	5	21	12			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From D [CBR, S] To F [CTL, N]

		1	19					0	0		
		11	12					0	0		
13	14	20	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	10			0	0	0	0
		22	9	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From D [CBL, W] To F [CTL, N]

		6	10					0	0		
		11	12					0	0		
1	14	19	2	5	22	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	9			0	0	0	0
		13	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From B [CTL, N] To F [CTL, N]

		9	10					0	0		
		17	12					0	0		
13	14	21	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		11	18	1	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From B [CTR, E] To F [CTL, N]

		9	10					0	0		
		17	12					0	0		
13	14	22	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		11	18	21	1			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From B [CBR, S] To F [CTL, N]

		9	10					0	0		
		17	12					0	0		
13	14	24	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		11	18	21	22			0	0	0	0
		19	20	23	1			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 1: From B [CBL, W] To F [CTL, N]

		9	10					0	0		
		17	12					0	0		
13	14	23	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		11	18	21	22			0	0	0	0
		19	20	1	24			0	0	0	0

Step 2 (Check: done)

Algorithm Set 1 – Center Cubes States – Step 2: From F [CTL, W] To F [CTR, N]

		9	10					0	0		
		11	12					0	0		
13	2	14	1	21	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	22	5			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From F [CBR, E] To F [CTR, N]

		9	2					0	0		
		11	12					0	0		
13	14	1	4	5	6	0	0	0	0	0	0
15	16	3	10	7	8	0	0	0	0	0	0
		17	18	23	22			0	0	0	0
		19	21	20	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From F [CBL, S] To F [CTR, N]

		9	2					0	0		
		11	12					0	0		
13	14	1	3	5	6	0	0	0	0	0	0
15	16	10	4	7	8	0	0	0	0	0	0
		17	18	24	22			0	0	0	0
		19	21	23	20			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From R [CTL, W] To F [CTR, N]

		9	10					0	0		
		11	21					0	0		
13	12	1	5	18	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	2	14	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From R [CTR, N] To F [CTR, N]

		9	21					0	0		
		11	12					0	0		
10	14	1	6	5	20	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	13	22			0	0	0	0
		19	2	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From R [CBR, E] To F [CTR, N]

		9	2					0	0		
		11	12					0	0		
13	14	1	8	5	6	0	0	0	0	0	0
20	16	3	4	7	10	0	0	0	0	0	0
		17	18	15	22			0	0	0	0
		19	21	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From R [CBL, S] To F [CTR, N]

		9	10					0	0		
		11	12					0	0		
13	2	1	7	21	6	0	0	0	0	0	0
15	5	3	4	14	8	0	0	0	0	0	0
		17	18	16	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From U [CTL, W] To F [CTR, N]

		6	10					0	0		
		11	12					0	0		
21	14	1	9	5	2	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	19	22			0	0	0	0
		13	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From U [CTR, N] To F [CTR, N]

		9	13					0	0		
		11	12					0	0		
2	14	1	10	5	21	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	20	22			0	0	0	0
		19	6	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From U [CBR, E] To F [CTR, N]

		9	10					0	0		
		11	14					0	0		
13	2	1	12	21	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	5	18	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From U [CBL, S] To F [CTR, N]

		9	10					0	0		
		18	21					0	0		
13	14	1	11	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		12	2	17	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From L [CTL, W] To F [CTR, N]

		9	2					0	0		
		11	12					0	0		
10	14	1	13	5	20	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	6	22			0	0	0	0
		19	21	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From L [CTR, N] To F [CTR, N]

		9	10					0	0		
		21	12					0	0		
13	17	1	14	11	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		2	18	5	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From L [CBR, E] To F [CTR, N]

		9	10					0	0		
		11	21					0	0		
13	14	1	16	5	6	0	0	0	0	0	0
15	18	3	4	12	8	0	0	0	0	0	0
		17	2	7	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From L [CBL, S] To F [CTR, N]

		9	10					0	0		
		11	12					0	0		
21	14	1	15	5	2	0	0	0	0	0	0
6	16	3	4	7	13	0	0	0	0	0	0
		17	18	8	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From D [CTL, W] To F [CTR, N]

		9	10					0	0		
		5	12					0	0		
13	2	1	17	21	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		14	18	11	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From D [CTR, N] To F [CTR, N]

		9	10					0	0		
		11	14					0	0		
13	21	1	18	2	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	5	12	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From D [CBR, E] To F [CTR, N]

		9	13					0	0		
		11	12					0	0		
21	14	1	20	5	2	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	10	22			0	0	0	0
		19	6	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From D [CBL, S] To F [CTR, N]

		20	2					0	0		
		11	12					0	0		
13	14	1	19	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	9	22			0	0	0	0
		10	21	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From B [CTL, W] To F [CTR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	21	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	12	2	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From B [CTR, N] To F [CTR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	22	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	12	21	2			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From B [CBR, E] To F [CTR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	24	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	12	21	22			0	0	0	0
		19	20	23	2			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 2: From B [CBL, S] To F [CTR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	23	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	12	21	22			0	0	0	0
		19	20	2	24			0	0	0	0

Step 3 (Check: done)

Algorithm Set 1 – Center Cubes States – Step 3: From F [CTL, S] To F [CBR, N]

		9	10					0	0		
		11	4					0	0		
13	14	12	2	5	6	0	0	0	0	0	0
15	16	3	1	7	8	0	0	0	0	0	0
		17	23	21	18			0	0	0	0
		19	20	22	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From F [CTR, W] To F [CBR, N]

		9	10					0	0		
		11	4					0	0		
13	14	1	12	5	6	0	0	0	0	0	0
15	16	3	2	7	8	0	0	0	0	0	0
		17	23	18	22			0	0	0	0
		19	20	21	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From F [CBL, E] To F [CBR, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
23	16	8	3	7	4	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	24	15			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From R [CTL, S] To F [CBR, N]

		9	10					0	0		
		11	12					0	0		
13	7	1	2	16	6	0	0	0	0	0	0
15	4	3	5	23	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	14	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From R [CTR, W] To F [CBR, N]

		9	23					0	0		
		11	12					0	0		
10	14	1	2	5	20	0	0	0	0	0	0
15	16	3	6	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	4	13	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From R [CBR, N] To F [CBR, N]

		23	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
9	16	3	8	7	19	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		4	20	15	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From R [CBL, E] To F [CBR, N]

		9	10					0	0		
		11	4					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	18	3	7	12	8	0	0	0	0	0	0
		17	23	21	22			0	0	0	0
		19	20	16	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From U [CTL, S] To F [CBR, N]

		20	23					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	9	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		10	4	19	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From U [CTR, W] To F [CBR, N]

		9	8					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
23	16	3	10	7	4	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	15	20	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From U [CBR, N] To F [CBR, N]

		9	10					0	0		
		11	14					0	0		
13	4	1	2	23	6	0	0	0	0	0	0
15	16	3	12	7	8	0	0	0	0	0	0
		17	5	21	22			0	0	0	0
		19	20	18	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From U [CBL, E] To F [CBR, N]

		9	10					0	0		
		16	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	4	3	11	23	8	0	0	0	0	0	0
		7	18	21	22			0	0	0	0
		19	20	17	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From L [CTL, S] To F [CBR, N]

		9	10					0	0		
		11	12					0	0		
8	14	1	2	5	15	0	0	0	0	0	0
23	16	3	13	7	4	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	6	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From L [CTR, W] To F [CBR, N]

		9	10					0	0		
		11	4					0	0		
13	12	1	2	18	6	0	0	0	0	0	0
15	16	3	14	7	8	0	0	0	0	0	0
		17	23	21	22			0	0	0	0
		19	20	5	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From L [CBR, N] To F [CBR, N]

		9	10					0	0		
		11	23					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	18	3	16	12	8	0	0	0	0	0	0
		17	4	21	22			0	0	0	0
		19	20	7	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From L [CBL, E] To F [CBR, N]

		9	23					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
20	16	3	15	7	10	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	4	8	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From D [CTL, S] To F [CBR, N]

		9	10					0	0		
		18	4					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	17	7	8	0	0	0	0	0	0
		12	23	21	22			0	0	0	0
		19	20	11	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From D [CTR, W] To F [CBR, N]

		9	10					0	0		
		11	7					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	4	3	18	23	8	0	0	0	0	0	0
		17	16	21	22			0	0	0	0
		19	20	12	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From D [CBR, N] To F [CBR, N]

		9	8					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
4	16	3	20	7	23	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	15	10	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From D [CBL, E] To F [CBR, N]

		15	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
23	16	3	19	7	4	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		8	20	9	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From B [CTL, S] To F [CBR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	21	7	8	0	0	0	0	0	0
		17	12	4	22			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From B [CTR, W] To F [CBR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	22	7	8	0	0	0	0	0	0
		17	12	21	4			0	0	0	0
		19	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From B [CBR, N] To F [CBR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	24	7	8	0	0	0	0	0	0
		17	12	21	22			0	0	0	0
		19	20	23	4			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 3: From B [CBL, E] To F [CBR, N]

		9	10					0	0		
		11	18					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	23	7	8	0	0	0	0	0	0
		17	12	21	22			0	0	0	0
		19	20	4	24			0	0	0	0

Step 4 (Check: done)

Algorithm Set 1 – Center Cubes States – Step 4: From F [CTL, E] To F [CBL, N]

		9	10					0	0		
		3	12					0	0		
13	14	11	2	5	6	0	0	0	0	0	0
15	16	1	4	7	8	0	0	0	0	0	0
		24	18	21	17			0	0	0	0
		19	20	23	22			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From F [CTR, S] To F [CBL, N]

		9	10					0	0		
		3	12					0	0		
13	14	1	11	5	6	0	0	0	0	0	0
15	16	2	4	7	8	0	0	0	0	0	0
		24	18	17	22			0	0	0	0
		19	20	23	21			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From F [CBR, W] To F [CBL, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	24	4	7	3	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	16	23			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From R [CTL, E] To F [CBL, N]

		9	10					0	0		
		3	12					0	0		
13	17	1	2	11	6	0	0	0	0	0	0
15	16	5	4	7	8	0	0	0	0	0	0
		24	18	21	22			0	0	0	0
		19	20	23	14			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From R [CTR, S] To F [CBL, N]

		9	10					0	0		
		11	12					0	0		
8	14	1	2	5	15	0	0	0	0	0	0
3	16	6	4	7	24	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	23	13			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From R [CBR, W] To F [CBL, N]

		24	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
9	16	8	4	7	19	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		3	20	23	15			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From R [CBL, N] To F [CBL, N]

		9	10					0	0		
		11	3					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	18	7	4	12	8	0	0	0	0	0	0
		17	24	21	22			0	0	0	0
		19	20	23	16			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From U [CTL, E] To F [CBL, N]

		15	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
3	16	9	4	7	24	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		8	20	23	19			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From U [CTR, S] To F [CBL, N]

		24	19					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	10	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		3	9	23	20			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From U [CBR, W] To F [CBL, N]

		9	10					0	0		
		11	7					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	24	12	4	3	8	0	0	0	0	0	0
		17	16	21	22			0	0	0	0
		19	20	23	18			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From U [CBL, N] To F [CBL, N]

		9	10					0	0		
		18	24					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	11	4	7	8	0	0	0	0	0	0
		12	3	21	22			0	0	0	0
		19	20	23	17			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From L [CTL, E] To F [CBL, N]

		24	10					0	0		
		11	12					0	0		
19	14	1	2	5	9	0	0	0	0	0	0
15	16	13	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		3	20	23	6			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From L [CTR, S] To F [CBL, N]

		9	10					0	0		
		11	12					0	0		
13	7	1	2	16	6	0	0	0	0	0	0
15	24	14	4	3	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	23	5			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From L [CBR, W] To F [CBL, N]

		9	10					0	0		
		3	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	11	16	4	17	8	0	0	0	0	0	0
		24	18	21	22			0	0	0	0
		19	20	23	7			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From L [CBL, N] To F [CBL, N]

		9	24					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
20	16	15	4	7	10	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	3	23	8			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From D [CTL, E] To F [CBL, N]

		9	10					0	0		
		16	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	24	17	4	3	8	0	0	0	0	0	0
		7	18	21	22			0	0	0	0
		19	20	23	11			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From D [CTR, S] To F [CBL, N]

		9	10					0	0		
		3	17					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	18	4	7	8	0	0	0	0	0	0
		24	11	21	22			0	0	0	0
		19	20	23	12			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From D [CBR, W] To F [CBL, N]

		9	8					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
3	16	20	4	7	24	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	15	23	10			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From D [CBL, N] To F [CBL, N]

		20	3					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	19	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		10	24	23	9			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From B [CTL, E] To F [CBL, N]

		19	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	21	4	7	8	0	0	0	0	0	0
		17	18	3	22			0	0	0	0
		9	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From B [CTR, S] To F [CBL, N]

		19	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	22	4	7	8	0	0	0	0	0	0
		17	18	21	3			0	0	0	0
		9	20	23	24			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From B [CBR, W] To F [CBL, N]

		19	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	24	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		9	20	23	3			0	0	0	0

Algorithm Set 1 – Center Cubes States – Step 4: From B [CBL, N] To F [CBL, N]

		19	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	23	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		9	20	3	24			0	0	0	0

4x4x4 Cube Wire Grid Model

Using a wire grid model, it is easy to see through the cube where letters are. This model can be used with pencil and rubber to find a path on the cube.

This model may be used to find algorithms for moving a single character from a location to another.

