Digital Altimeter Cube Design

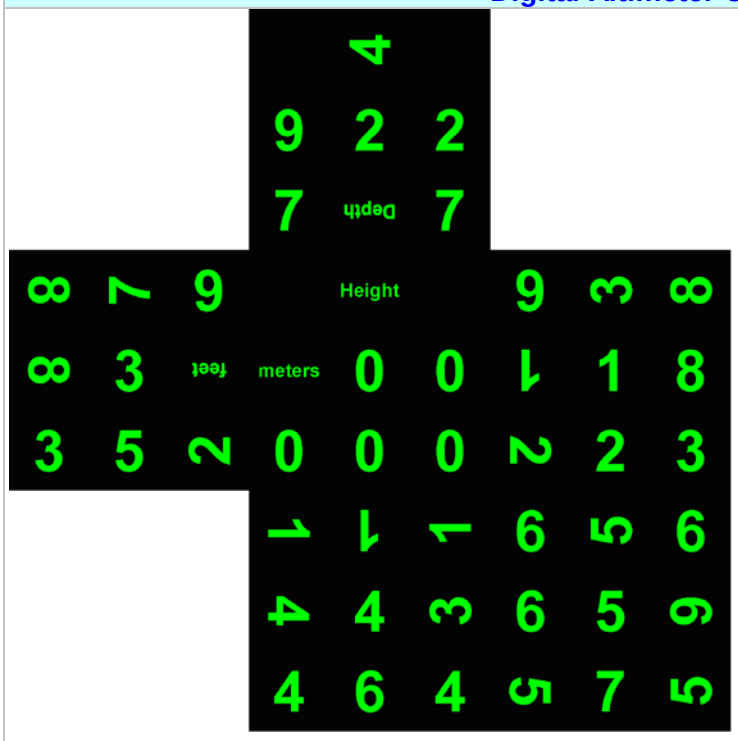
Preliminary Document

Introduction

A **Digital Altimeter Cube** is a 3x3x3 **Rubik's Cube** used for indicating the elevation above (height) or below (depth) a fixed reference level.

Altimeter – Useful Links	
http://en.wikipedia.org/wiki/Altimeter	http://www.suuntowatches.com/
http://www.swissarmy.com/CustomerService/Documents/UserManuals/altimetermanual.pdf	

There are **virtual cubes** that can be *virtually* rotated and twisted on a computer screen and **real cubes** that can only be *physically* rotated and twisted by hand. A **texture** is laid down on a virtual cube whereas real **stickers** are stuck down on a real cube. A Digital Altimeter Cube is designed by placing numerals and symbols on a texture which is then laid down on a virtual cube (see http://www.randelshofer.ch/ for more details). The height or depth can be displayed on a *selected* cube face by rotating and twisting some parts of the cube. When this has been achieved, we say that the cube has been *solved*. The following example shows the *initial* state of the cube where an height of '00000' meters is displayed on the front face.

Digital Altimeter Cube – Initial State	
	
Cube Texture	Virtual Cube

Digital Altimeter Cube Features

The cube can be used in 3 modes:

1- Mode A (Height in meters or feet): from 00000 to 59999 in 1 meter or 1 foot steps*
2- Mode B (Depth in meters or feet): from 00000 to 59999 in 1 meter or 1 foot steps*
3- Mode C (Constants display): see List of Constants

* 1 foot = 0.3048 meter

The highest and deepest points on Earth are Mt Everest (8844 m or 29 029 ft) and Mariana Trench (11 033 m or 36 201 ft) respectively. The troposphere altitude varies between 10 and 50 km. All these values can be displayed on the cube.

Examples of Altimeters

Digital Altimeter	Analog Altimeter
Victorinox Digital Altimeter Knife	Aircraft Altimeter
	

Examples of Digital Altimeter Cube Synthesized Algorithms

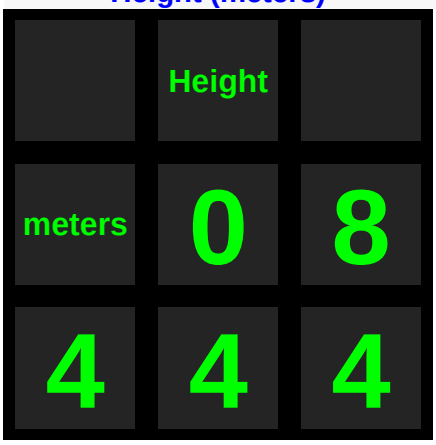
Digital Altimeter Cube Synthesized Algorithms (To be completed)	
Height = 8844 m or 29029 ft (Mount Everest)	
Setup Algorithms	
Depth = 10923 m or 35 838 ft	
Setup Algorithms	

Digital Altimeter Cube Synthesized Algorithms (To be completed)	
π = 3.1416	
Setup Algorithms	
Setup Algorithms	

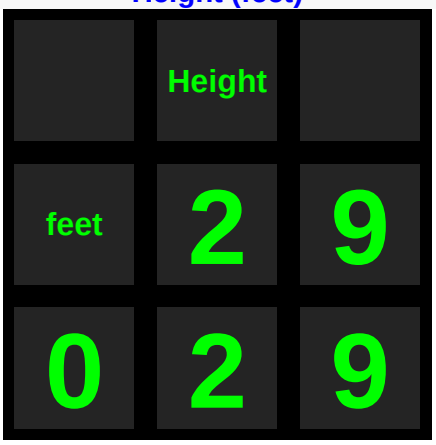
Digital Altimeter Cube Display Modes

Mode A: Height

Height (meters)

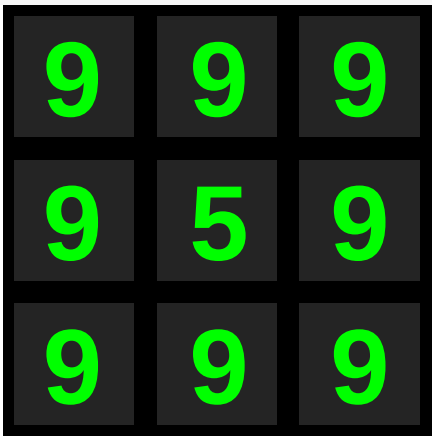


Height (feet)



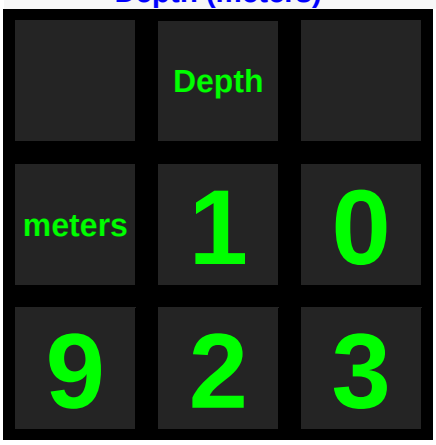
Mode C: Constant

Constant

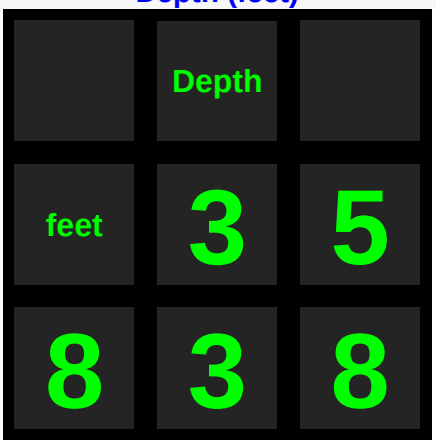


Mode B: Depth

Depth (meters)

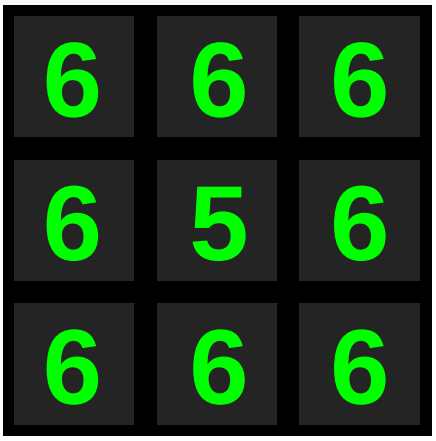


Depth (feet)



Mode C: Constant

Constant



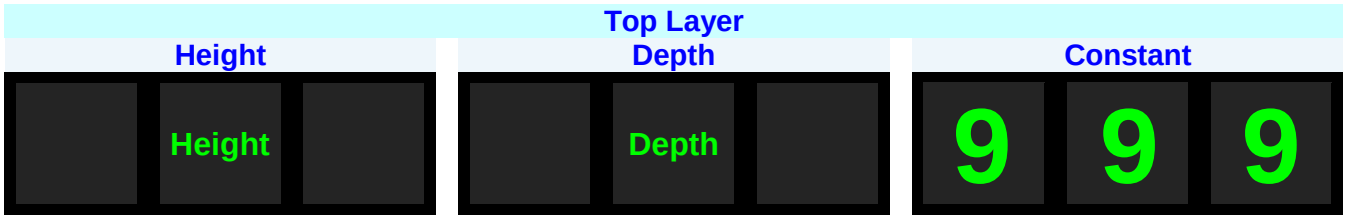
List of Constants

The following numbers can be displayed on the cube.

Numbers		
Number	Name	Displayed Value
999 959 999		999959999
666 656 666		666656666
969 959 969		969959969
696 656 696		696656696

Digital Altimeter Cube Design

Top Layer Layout



Symbols on the **T**op **L**ayer are sorted out as follows:

1- 2 **T**op **L**eft blanks on 2 corner cubes (see **B**ottom **L**ayer Layout): blank_**T**op**L**ayer, blank_**T**op**L**ayer
2- 2 **T**op **C**enter symbols on 1 edge cube: 'Height', 'Depth'
3- 2 **T**op **R**ight blanks on 2 corner cubes (see **B**ottom **L**ayer Layout): blank_**T**op**L**ayer, blank_**T**op**L**ayer

Numerals, blanks and symbols are now logically combined on corner and edge cubes:

1- 2 **T**op **L**eft corner cubes (see **B**ottom **L**ayer Layout)
2- 1 **T**op **C**enter edge cube: ['Height', 'Depth']
3- 2 **T**op **R**ight corner cubes (see **B**ottom **L**ayer Layout)

Note 1 – This ensures that there are at least 2 **T**op **L**ayer blanks available at any time on corner cubes.

So, now there are 8 corner and 11 edge cubes left that can be used for the 2 remaining layers.

Middle Layer Layout

Numerals and symbols on the **M**iddle **L**ayer are sorted out as follows:

1- 2 **M**iddle **L**eft symbols on 1 edge cube: 'meters', 'feet' or 'm', 'ft'
2- 6 **M**iddle **C**enter numerals on center cubes: 0, 1, 2, 3, 4, 5
3- 10 **M**iddle **R**ight numerals on edge cubes: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Letters and symbols are now logically combined on edge cubes:

1- 1 **M**iddle **L**eft edge cube: ['meters', 'feet'] or ['m', 'ft']
2- 5 **M**iddle **R**ight edge cubes: [0, 1], [2, 3], [4, 5], [6, 7], [8, 9]

So, now there are 8 corner and 5 edge cubes left that can be used for the **B**ottom **L**ayer.

Bottom Layer Layout

Bottom Layer								
Meters			Feet			Constant		
8	4	4	0	2	9	9	9	9

Numerals on the **B**ottom **L**ayer are sorted out as follows:

1- 10 **B**ottom **L**eft numerals on corner cubes: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
2- 6 **B**ottom **C**enter numerals on edge cubes: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
3- 10 **B**ottom **R**ight numerals on corner cubes: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Numerals and symbols are now combined on corner and edge cubes:

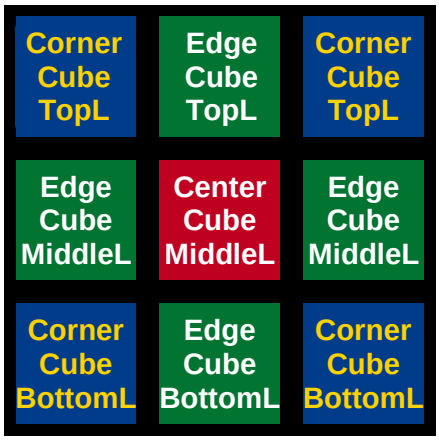
1- 4 **B**ottom **L**eft corner cubes: [0, 1, 2], [3, 4, 5], [6, 7, blank_**T**op**L**ayer], [8, 9, blank_**T**op**L**ayer]
2- 5 **B**ottom **C**enter edge cubes: [0, 1], [2, 3], [4, 5], [6, 7], [8, 9]
3- 4 **B**ottom **R**ight corner cubes: [0, 1, 2], [3, 4, 5], [6, 7, blank_**T**op**L**ayer], [8, 9, blank_**T**op**L**ayer]

Digital Altimeter Cube Layout Table		
Top **L**eft – Corner cube	**T**op **C**enter – Edge cube	**T**op **R**ight – Corner cube
blank	'Height', 'Depth'	blank
Middle **L**eft – Edge cube	**M**iddle **C**enter – Center cubes	**M**iddle **R**ight – Edge cubes
'meters', 'feet'	0, 1, 2, 3, 4, 5	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Bottom **L**eft – Corner cubes	**B**ottom **C**enter – Edge cubes	**B**ottom **R**ight – Corner cubes
0, 1, 2, 3, 4, 5, 6, 7, 8, 9	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Digital Altimeter Cube – Constants Layout Table		
Top **L**eft – Corner cube	**T**op **C**enter – Edge cube	**T**op **R**ight – Corner cube
0, 9, 6, blank	0, 9, 6	0, 9, 6, blank
Middle **L**eft – Edge cube	**M**iddle **C**enter – Center cubes	**M**iddle **R**ight – Edge cubes
0, 9, 6	0, 1, 2, 3, 4, 5	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Bottom **L**eft – Corner cubes	**B**ottom **C**enter – Edge cubes	**B**ottom **R**ight – Corner cubes
0, 1, 2, 3, 4, 5, 6, 7, 8, 9, blank	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, blank

Terminology

In a 3x3x3 **Rubik's Cube**, there are 8 *Corner Cubes*, 12 *Edge Cubes*, 6 *Center Cubes* and 6 *Cube Faces*. There are also 4 Corner Cube faces, 4 Edge Cube faces and 1 Center Cube face *per Cube Face*, as shown below.



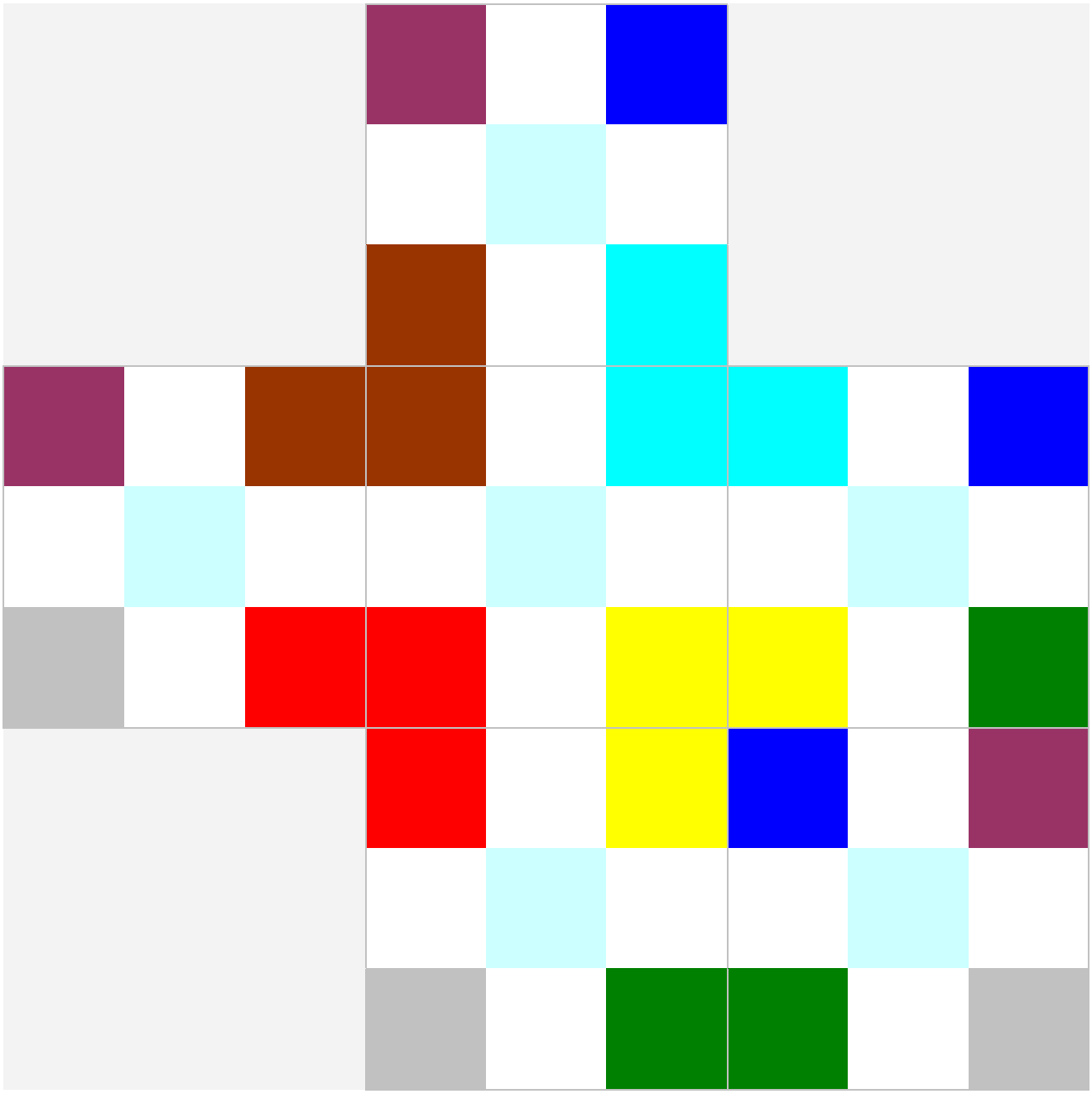
There are 1 face per Center Cube, 2 faces per Edge Cube and 3 faces per Corner Cube.

There are also 3 horizontal *Layers* called *Top*, *Middle* and *Bottom Layers*.

Cube Lexicon		
English	**Français**	**Deutsch**
Cube	Cube	Würfel
cubie, cube	cube, petit cube	Würfelteil, Teil des Würfels
face	face	Seite, Seitenfläche
front face	face avant	vordere Seite, vorne
back face	face arrière	hintere Seite, hinten
left face	face gauche	linke Seite, links
right face	face droite	rechte Seite, rechts
top face	face supérieure	obere Seite, oben
bottom face	face inférieure	untere Seite, unten
sticker	étiquette (autocollante), plaquette	Kleber, Farbkleber
tile	tuile, plaquette	Plättchen, Farbplättchen
center cube, center	cube central, centre	Mittelwürfel, Mittelstein, Mitte
edge cube, edge	cube-arête, arête	Kantenwürfel, Kantenstein, Kante
corner cube, corner	cube de coin, coin	Eckwürfel, Eckstein, Ecke
layer	couronne	Schicht, Scheibe
top layer	couronne supérieure	obere Schicht, obere Scheibe
middle layer	couronne intermédiaire	mittlere Schicht, mittlere Scheibe, Mittelschicht, Mittelscheibe
bottom layer	couronne inférieure	untere Schicht, untere Scheibe
orientation, direction	orientation	Orientierung
to solve	résoudre	lösen, zusammen drehen
to twist	pivoter	drehen
to rotate	tourner, effectuer une rotation	drehen
clockwise	dans le sens horaire	im Uhrzeigersinn
anticlockwise, counter-clockwise	dans le sens anti-horaire	im Gegenuhrzeigersinn

Corner Cubes Final Check

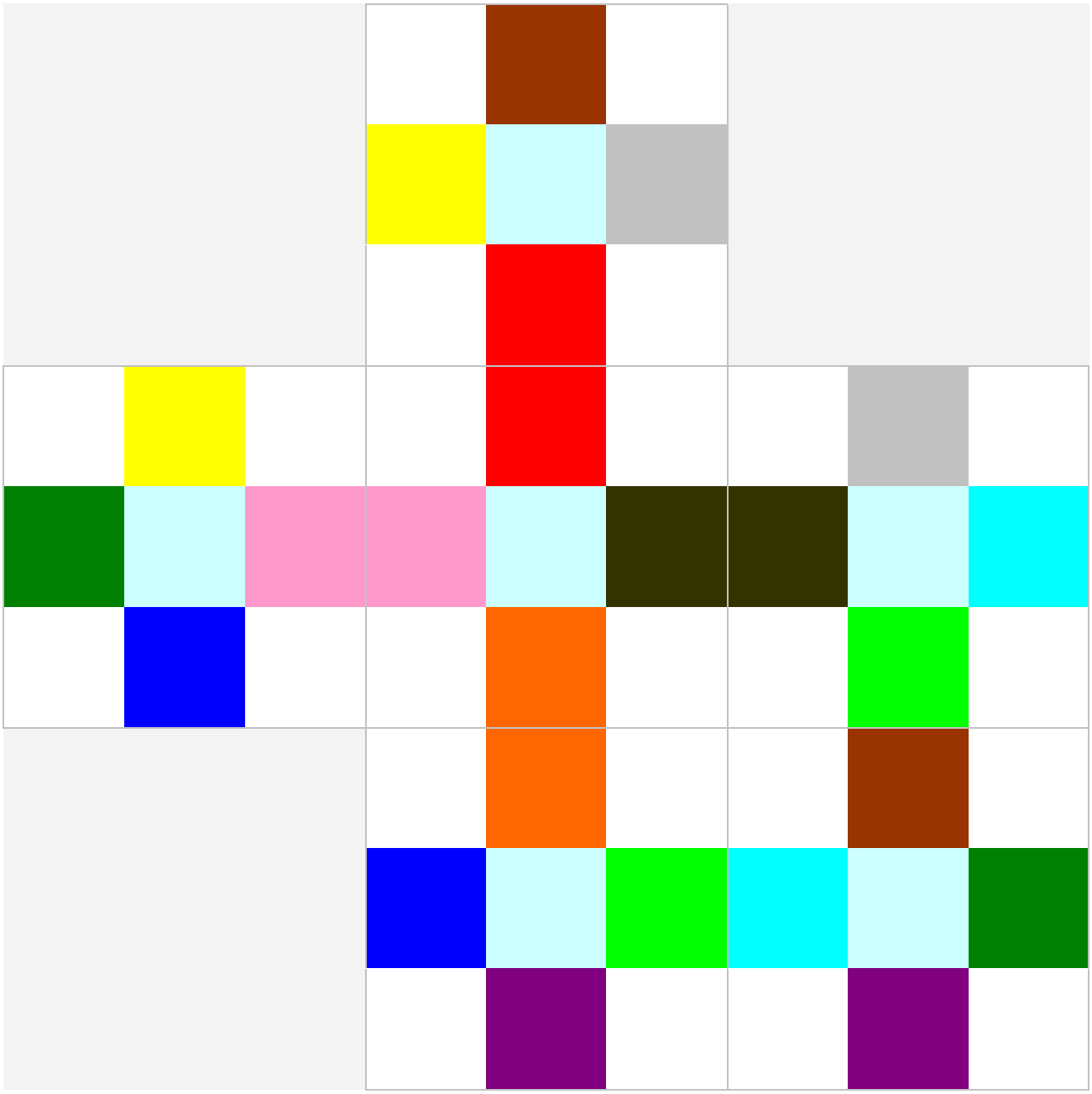
There are 8 Corner Cubes and 3 faces per Corner Cube. In the diagram below, each Corner Cube is displayed in 8 different colors and with the same color applied to each of its 3 faces. This diagram can be used as a convenient *visual aid* to check Design Rules (DRC).



	Up		
Left	**F**ront	**R**ight	**B**ack
	Down	**B**ack	

Edge Cubes Final Check

There are 12 Edge Cubes and 2 faces per Edge Cube. In the diagram below, each Edge Cube is displayed in 12 different colors and with the same color applied to each of its 2 faces. This diagram can be used as a convenient *visual aid* to check Design Rules (DRC).



	Up		
Left	**F**ront	**R**ight	**B**ack
	Down	**B**ack	

Texture Template

This is a texture template that can be printed out and used for writing down numbers and letters by hand *prior to* texture design. All is needed are pencil, rubber…and time.