

# Digital Calendar Cube Design

## Introduction

A **Digital Calendar Cube** is a 3x3x3 **Rubik's Cube** used for indicating the date of the day. In most calendar systems, the date consists of three parts: *day of month*, *month*, and *year*. There may also be additional parts, such as *weekday*. Different formats are used to express the date. The mm/dd/yy (month, day, year) format is mainly used in the United States. The Digital Calendar Cube displays the date of the day using this latter format and the week is also displayed using the US week numbering system.

### Digital Calendar Cube – Useful Links

|   |   |
|---|---|
| <a href="http://en.wikipedia.org/wiki/Calendar_date">http://en.wikipedia.org/wiki/Calendar_date</a>                 | <a href="http://en.wikipedia.org/wiki/Calendar">http://en.wikipedia.org/wiki/Calendar</a>                     |
| <a href="http://javascript.about.com/library/blweekyear.htm">http://javascript.about.com/library/blweekyear.htm</a> | <a href="http://en.wikipedia.org/wiki/Seven-day_week">http://en.wikipedia.org/wiki/Seven-day_week</a>         |
| <a href="http://en.wikipedia.org/wiki/ISO_week_date">http://en.wikipedia.org/wiki/ISO_week_date</a>                 | <a href="http://en.wikipedia.org/wiki/Leap_week_calendar">http://en.wikipedia.org/wiki/Leap_week_calendar</a> |

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 Calendar Cube is designed by placing numerals on a texture which is then laid down on a Virtual Cube (see <http://www.randelshofer.ch/> for more details). The date of the day 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 'MONTH 1 DAY 01 YEAR 00' for 'January 1, 2000' is displayed on the front face.

### Digital Calendar Cube – Initial State 7-segment Display

|  |                     |                     |
|--|---------------------|---------------------|
| <p>Digital Calendar Cube</p> <p>Original design 2008<br/>by André Boulouard<br/>and Walter Randelshofer</p> <p>Copyright © 2008<br/>André Boulouard<br/>Walter Randelshofer<br/>Werner Randelshofer<br/>All rights reserved.</p> |                     |                     |
|  | <p>Cube Texture</p> | <p>Virtual Cube</p> |

## Digital Calendar Cube Features (7-segment Display)

The cube can be used in 2 modes:

- 1- Mode A (Daily calendar): from 1/01/00 (January 1, 2000) up to 12/31/99 (December 31, 2099) in 1 day steps
- 2- Mode B (Weekly calendar\*): from 1/01/00 (January, Week 01, 2000) up to 12/53/99 (December, Week 53, 2099) in 1 week steps

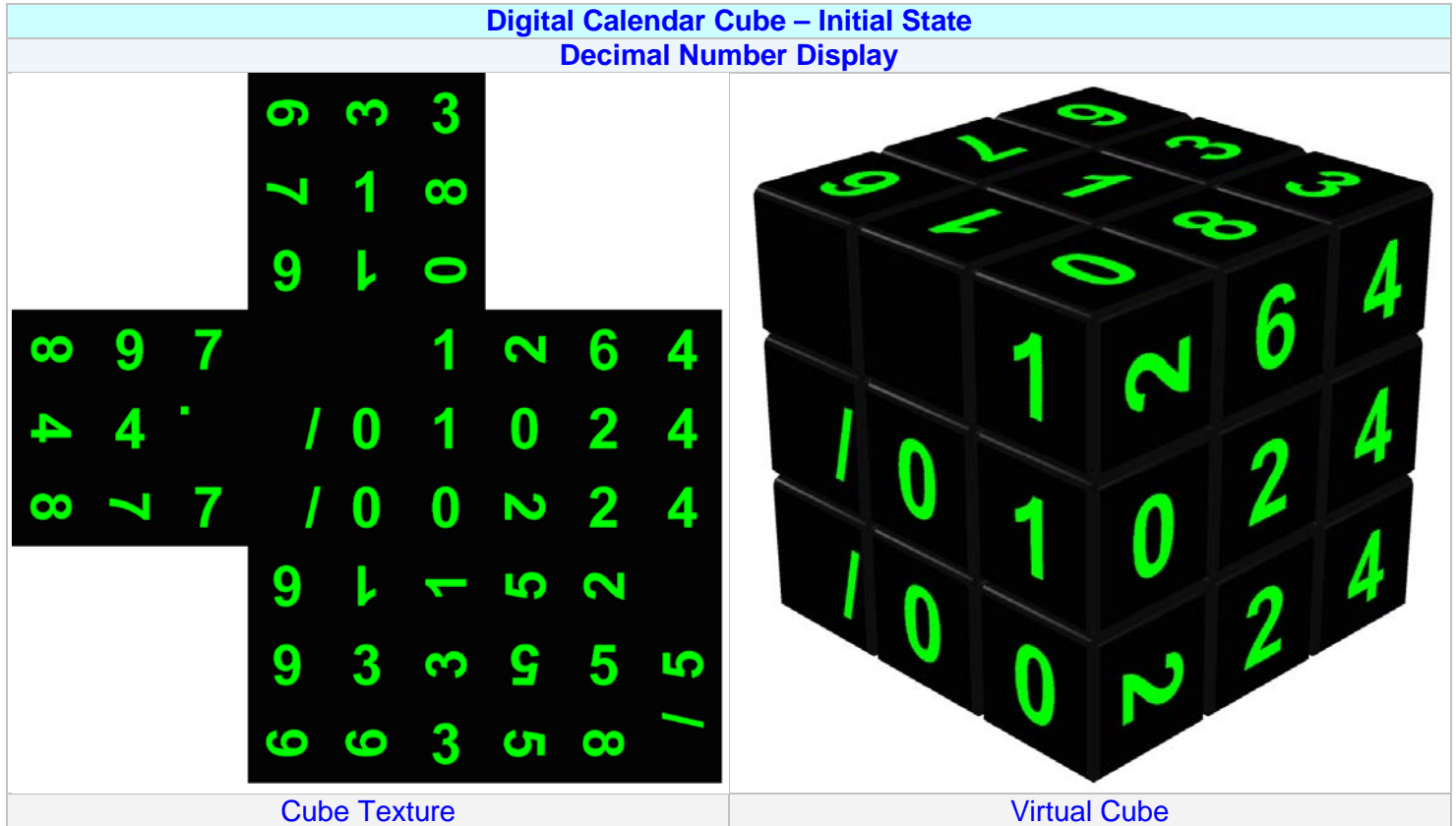
\*In the US week numbering system the last few days of the year will be in week 53 (or possibly 54 if it is a leap year starting on a Saturday).

## Alternate Design (Decimal Number Display)

In an alternate design, symbols 'MONTH', 'DAY', 'YEAR' and 'WEEK' are replaced with ' ' (blank), '/' (slash) and '.' (dot). The cube also can be used in 2 modes:

- 1- Mode A (Daily calendar): from 1/01/00 (January 1, 2000) up to 12/31/99 (December 31, 2099) in 1 day steps
- 2- Mode B (Mathematical & Physical Constants Display): see [List of Constants](#)

As there are 6 center cubes, 6 different numbers (0, 1, 2, 3, 4, 5) can be displayed on these cubies. This feature can be used to display some constants.



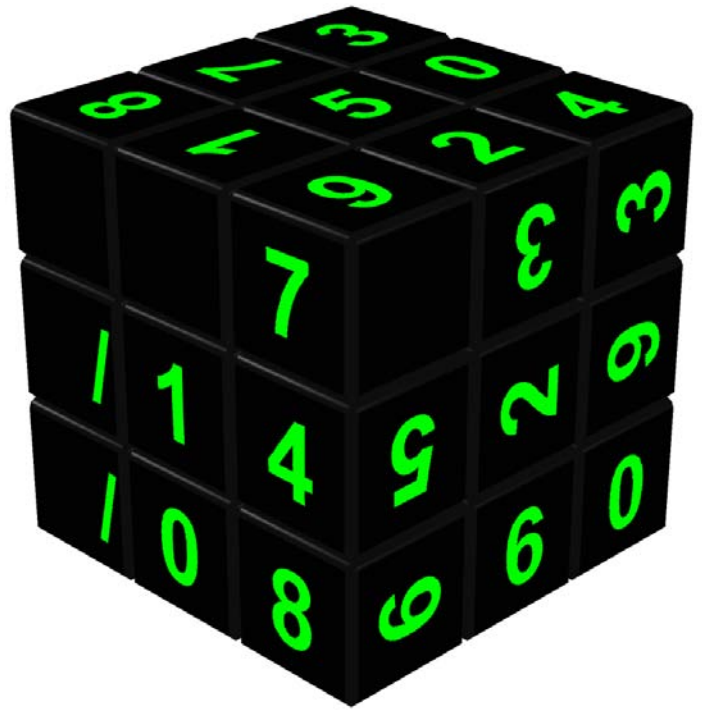
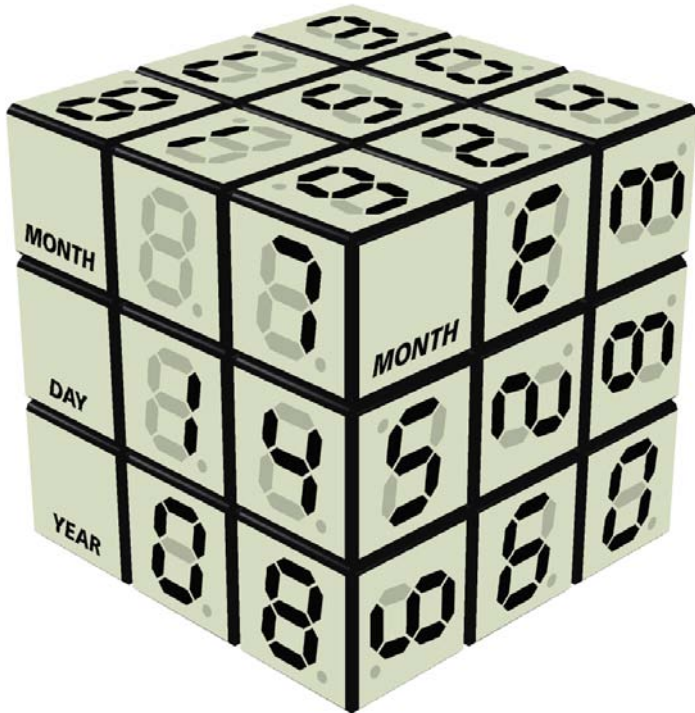
## US Week Numbering System

The US system has weeks from Sunday through Saturday, and partial weeks at the beginning and the end of the year. An advantage is that no separate year numbering like the ISO year is needed, while correspondence of lexicographical order and chronological order is preserved. The 1st January can fall on any day of the week and so not all of the days in that week will be in the current year but we'll consider the week that contains the 1st January to be week one of the current year even though not all of the days in that week are necessarily in the current year. So week one consists of those days between 1st January and the first Saturday on or after that date and the seven days following that make up week two and so on. Once we get to the end of December the last few days of the year will be in week 53 (or possibly 54 if it is a leap year starting on a Saturday).

# Examples of Digital Calendar Cube Synthesized Algorithms

## Digital Calendar Cube Synthesized Algorithms

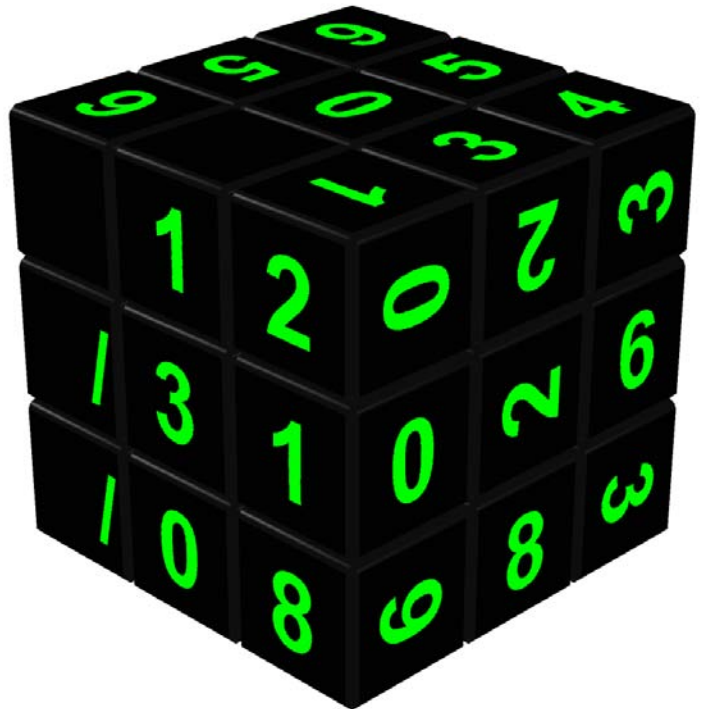
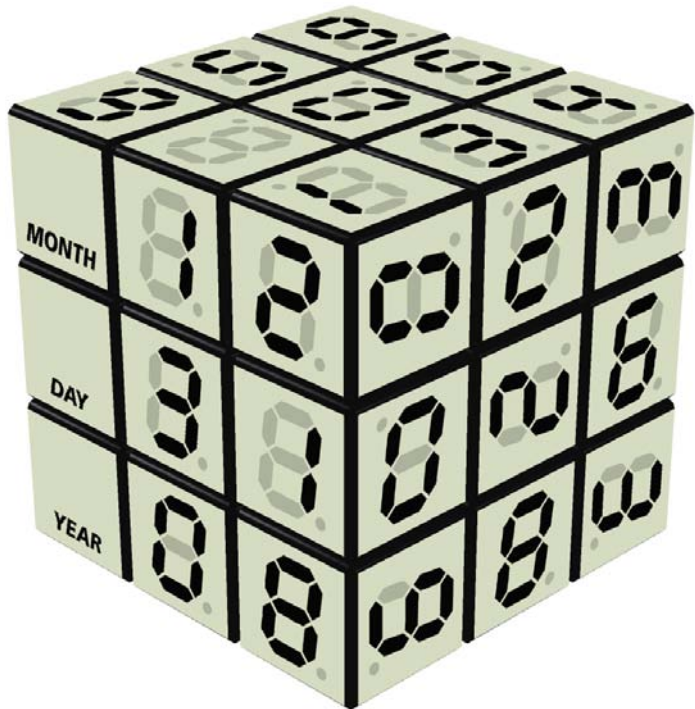
7/14/08 (July 14, 2008)



### Setup Algorithm

CR' D2 BR' UR' DBR2 U' B UL' D2 L' D' B U' B UR B2 R' B' R' BR

12/31/08 (December 31, 2008)



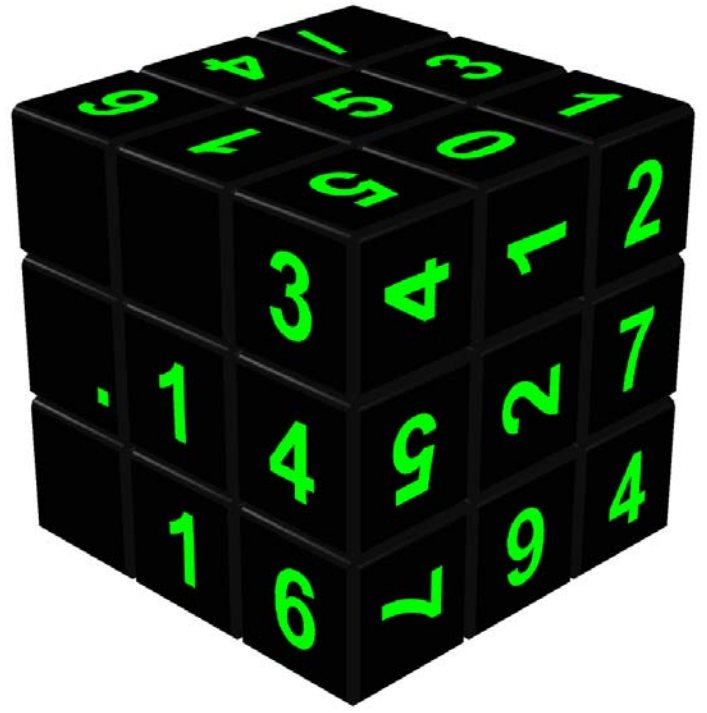
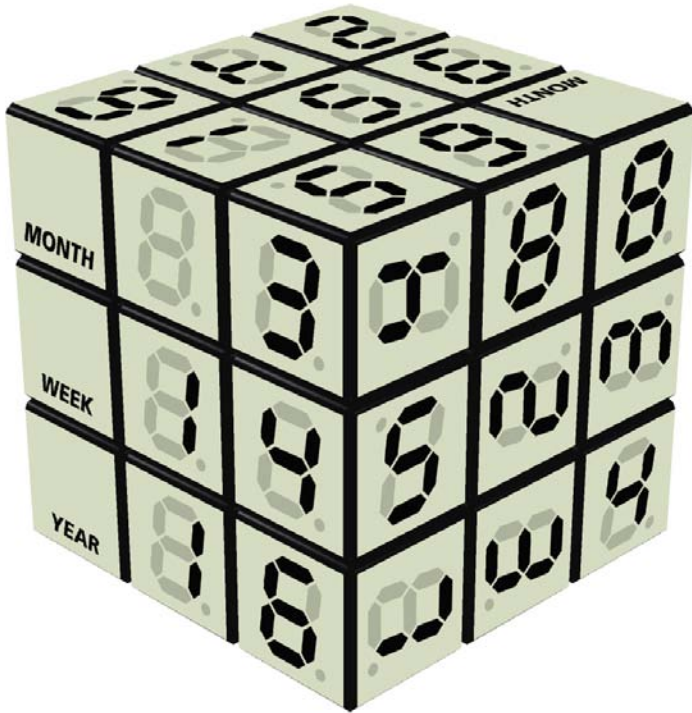
### Setup Algorithm

CR U2 L' B2 R2 D L B D2 B U' L U D U B2 U' D' R B2 R' U' B2 U B' R' B R D B2 D' B' D' B D

## Digital Calendar Cube Synthesized Algorithms

**MONTH = 3 WEEK = 14 YEAR = 2016**

**$\pi = 3.1416$**

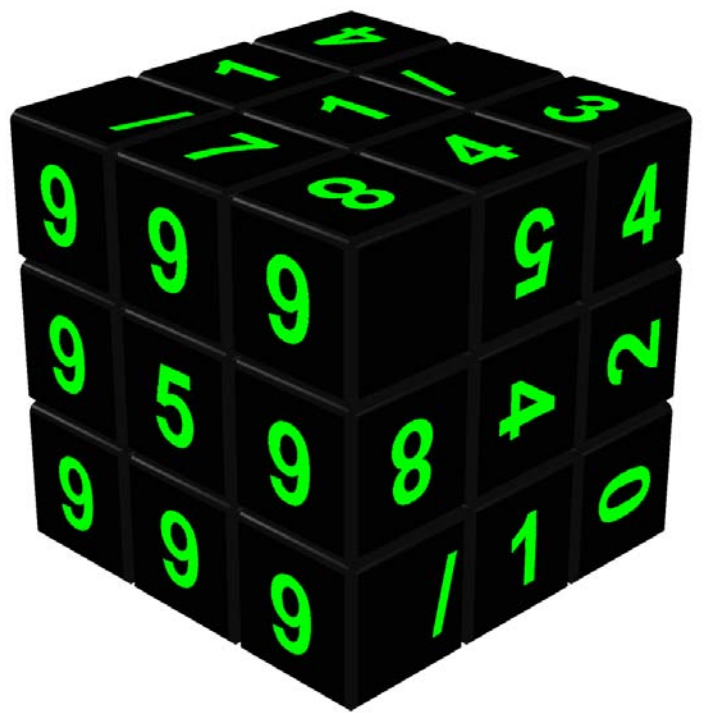


### Setup Algorithm

**(Week)** CR' D2 B R' U R' D B R2 U' B2 U D B' D L2 B' U B' U' L' B2 L2 B' L' B2 R' B R U' B U

**( $\pi$ )** CR' D2 B R' U R' D B R2 U' B2 U D2 D' B' D L2 B' U B' U' L' B2 L D U' B U D' B R' B R D B2 D' B L B' L'

**999 959 999**



### Setup Algorithm

CU2 U D R B2 D2 U' L U B U B' U' B' U' B U R B2 R2 B R D B2 D' B2 D' B D L B2 L'

# Digital Calendar Cube Display Modes (Decimal Number Display))

## Mode A: Date (MM/DD/YY)

2/29/08 (February 29, 2008)

|   |   |   |
|---|---|---|
|   |   | 2 |
| / | 2 | 9 |
| / | 0 | 8 |

7/14/08 (July 14, 2008)

|   |   |   |
|---|---|---|
|   |   | 7 |
| / | 1 | 4 |
| / | 0 | 8 |

12/31/08 (December 31, 2008)

|   |   |   |
|---|---|---|
|   | 1 | 2 |
| / | 3 | 1 |
| / | 0 | 8 |

M  
D  
Y

## Mode B: Mathematical & Physical Constants

|   |   |   |
|---|---|---|
|   |   | 3 |
| . | 1 | 4 |
|   | 1 | 6 |

$\pi$

|   |   |   |
|---|---|---|
|   |   | 2 |
| . | 2 | 3 |
| 6 | 0 | 6 |

$\sqrt{5}$

|   |   |   |
|---|---|---|
|   |   | 1 |
| . | 4 | 1 |
| 6 | 7 | 9 |

Planck temperature

# List of Mathematical & Physical Constants

The following mathematical & physical constants values can be displayed on the cube.

| Mathematical Constants             |                  |  |
|------------------------------------|------------------|--|
| Constant Name                      | Abbreviated Name | Truncated Constant Value                                   |
| Archimedes' constant Pi ( $\pi$ )  | $\pi$            | 3.1415 (3.1416)  |
| $\sqrt{2}$ (Pythagoras' constant)  | $\sqrt{2}$       | 1.4142   |
| $\sqrt{5}$ (Pythagorean constant)  | $\sqrt{5}$       | 2.23606  |
| $\sqrt{10}$ (Pythagorean constant) | $\sqrt{10}$      | 3.1622   |
| Plastic constant                   | $\rho$           | 1.3247   |
| Feigenbaum constant                | $\alpha$         | 2.5029   |
| Meissel-Mertens constant           | M1               | 0.2614   |
| Viswanath's constant               | K                | 1.1319   |
| Ramanujan-Soldner constant         | $\mu$            | 1.4513   |
| Bernstein's constant               | $\beta$          | 0.2801   |
| Gauss-Kuzmin-Wirsing constant      | $\lambda$        | 0.3036   |
| Hafner-Sarnak-McCurley constant    | $\sigma$         | 0.3532   |
| Apéry's constant                   | $\zeta(3)$       | 1.2020   |
| Mills' constant                    | $\theta$         | 1.30637  |
| Sierpiński's constant              | K                | 2.5849   |
| Parabolic constant                 | P2               | 2.2955   |
| Legendre's constant                | B'L              | 1.0836   |
| Backhouse's constant               |                  | 1.45607  |
| Khinchin-Lévy constant             |                  | 1.18656  |
| Lévy's constant                    |                  | 3.2758   |
| Physical Constants                 |                  |  |
| Constant Name                      | Abbreviated Name | Truncated Constant Value                                   |
| Planck or Dirac constant           | $\hbar$          | 1.0545 $\times 10^{-34}$ J·s                               |
| Planck mass                        | $m_p$            | 2.17645 $\times 10^{-8}$ kg                                |
| Planck time                        | $t_p$            | 5.3912 $\times 10^{-44}$ s                                 |
| Planck temperature                 | $T_p$            | 1.41679 $\times 10^{32}$ K                                 |
| von Klitzing constant              | $R_K$            | 2.5812 $\times 10^4$ $\Omega$                              |
| Boltzmann constant                 | k or $k_B$       | 1.3806 $\times 10^{-23}$ J·K <sup>-1</sup>                 |
| nuclear magneton                   |                  | 5.0507 $\times 10^{-27}$ J·T <sup>-1</sup>                 |
| Bohr radius                        |                  | 0.52917 $\times 10^{-10}$ m                                |
| Fermi coupling constant            |                  | 1.16639 $\times 10^{-5}$ GeV <sup>-2</sup>                 |
| First radiation constant           |                  | 1.1910 $\times 10^{-16}$ W·m <sup>2</sup> sr <sup>-1</sup> |
| gas constant                       |                  | 8.3144 $\times$ J·K <sup>-1</sup> ·mol <sup>-1</sup>       |
| weak mixing angle                  |                  | 0.2221   |
| Other Numbers                      |                  |  |
| Number                             | Name             | Displayed Value  |
| 999 959 999                        |                  | 999959999  |
| 666 656 666                        |                  | 666656666  |
| $(4/3)^{4/3}$                      |                  | 1.4675   |
| $(6/5)^{5/6}$                      |                  | 1.1640   |
| 10/9                               |                  | 1.1111   |
| 7/6                                |                  | 1.1515   |
| 1/3                                |                  | 0.3333   |
| 4/3                                |                  | 1.3333   |
| 7/3                                |                  | 2.3333   |
| 10/3                               |                  | 3.3333   |

# Digital Calendar Cube Design

## Top Layer Layout

### Decimal Number Display



Numerals on the Top Layer are sorted out as follows:

- 1- 2 Top Left blanks on corner cubes: blank, blank
- 2- 1 Top Center numeral and 1 blank on 1 edge cube: blank, 1
- 3- 10 Top Right numerals on corner cubes: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

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

- 1- 1 Top Center edge cube: [blank, 1]
- 2- 4 Top Right corner cubes: [0, 1, 2], [3, 4, 5], [6, 7, blank], [8, 9, blank]

**Note 1** – This ensures that there is at least 1 Top Left blank available at any time.

### 7-segment Display

- 1- 1 Top Center edge cube: [blank, 1]
- 2- 4 Top Right corner cubes: [0, 1, 2], [3, 4, 5], [6, 7, 'MONTH'], [8, 9, 'MONTH']

**Note 2** – This ensures that there is at least 1 Top Left word 'MONTH' available at any time.

So, now there are 4 corner and 11 edge cubes left that can be used for the 2 remaining layers.

## Middle Layer Layout

### Decimal Number Display



Numerals and symbols on the Middle Layer are sorted out as follows:

- 1- 2 Middle Left symbols on 1 edge cube: '/', '.'
- 2- 6 Middle Center numerals on center cubes: 0, 1, 2, 3, 4, 5
- 3- 10 Middle Right numerals on edge cubes: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Letters are now combined on edge cubes:

- 1- 1 Middle Left edge cube: ['/', '.']
- 2- 5 Middle Right edge cubes: [0, 1], [2, 3], [4, 5], [6, 7], [8, 9]

## 7-segment Display

- 1- 1 **M**iddle **L**eft edge cube: ['DAY', 'WEEK']
- 2- 5 **M**iddle **R**ight edge cubes: [0, 1], [2, 3], [4, 5], [6, 7], [8, 9]

So, now there are 4 corner and 5 edge cubes left that can be used for the **Bottom Layer**.

## Bottom Layer Layout

### Decimal Number Display



Numerals and symbols on the **Bottom Layer** are sorted out as follows:

- 1- 2 **B**ottom **L**eft symbols on corner cubes: '/', '/'
- 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- 5 **B**ottom **C**enter edge cubes: [0, 1], [2, 3], [4, 5], [6, 7], [8, 9]
- 2- 4 **B**ottom **R**ight corner cubes: [0, 1, 2], [3, 4, 5], [6, 7, '/'], [8, 9, '/'],

**Note 3** – This ensures that there is at least 1 **B**ottom **L**eft symbol '/' available at any time.

## 7-segment Display

- 1- 5 **B**ottom **C**enter edge cubes: [0, 1], [2, 3], [4, 5], [6, 7], [8, 9]
- 2- 4 **B**ottom **R**ight corner cubes: [0, 1, 2], [3, 4, 5], [6, 7, 'YEAR'], [8, 9, 'YEAR'],

**Note 4** – This ensures that there is at least 1 **B**ottom **L**eft word 'YEAR' available at any time.

**Digital Calendar Cube Layout Table – Decimal Number Display**

| Top <b>L</b> eft – Corner cube     | Top <b>C</b> enter – Edge cubes      | Top <b>R</b> ight – Corner cubes    |
|------------------------------------|--------------------------------------|-------------------------------------|
| blank                              | blank, 1                             | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9        |
| Middle <b>L</b> eft – Edge cubes   | Middle <b>C</b> enter – Center cubes | Middle <b>R</b> ight – Edge cubes   |
| ('/', '.')                         | 0, 1, 2, 3, 4, 5                     | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9        |
| Bottom <b>L</b> eft – Corner cubes | Bottom <b>C</b> enter – Edge cubes   | Bottom <b>R</b> ight – Corner cubes |
| ('/')                              | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9         | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9        |

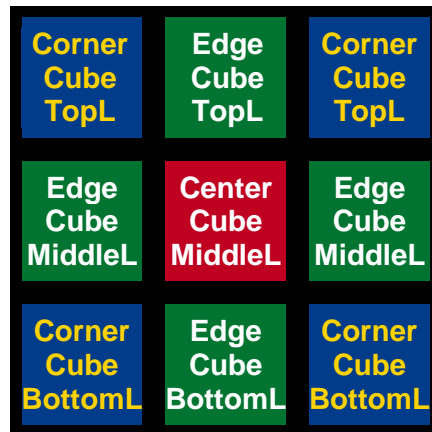
**Digital Calendar Cube Layout Table – 7-segment Display**

| Top <b>L</b> eft – Corner cube     | Top <b>C</b> enter – Edge cubes      | Top <b>R</b> ight – Corner cubes    |
|------------------------------------|--------------------------------------|-------------------------------------|
| 'MONTH'                            | blank, 1                             | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9        |
| Middle <b>L</b> eft – Edge cubes   | Middle <b>C</b> enter – Center cubes | Middle <b>R</b> ight – Edge cubes   |
| 'DAY', 'WEEK'                      | 0, 1, 2, 3, 4, 5                     | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9        |
| Bottom <b>L</b> eft – Corner cubes | Bottom <b>C</b> enter – Edge cubes   | Bottom <b>R</b> ight – Corner cubes |
| 'YEAR'                             | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9         | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9        |



## 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.



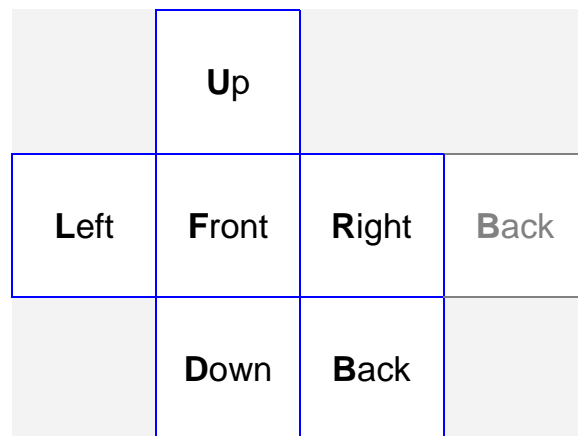
There are 1 face per Center Cube, 2 faces per Edge Cube and 3 faces per Corner Cube.

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

| Cube Lexicon                     |                                     |  |
|----------------------------------|-------------------------------------|--|
| English                          | Français                            | Deutsch  |
| Cube                             | Cube                                | Würfel   |
| cubeie, cube                     | cube, petit cube                    | Würfeteil, 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  |

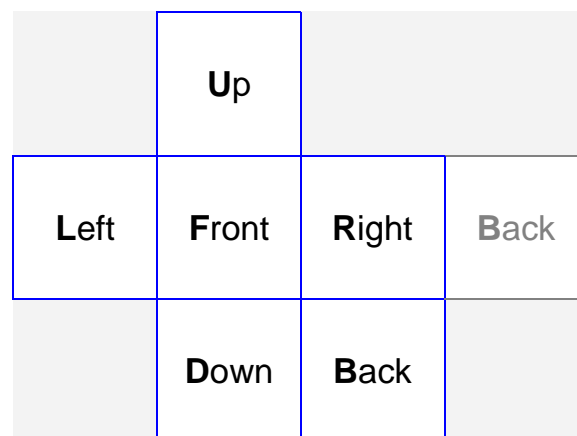
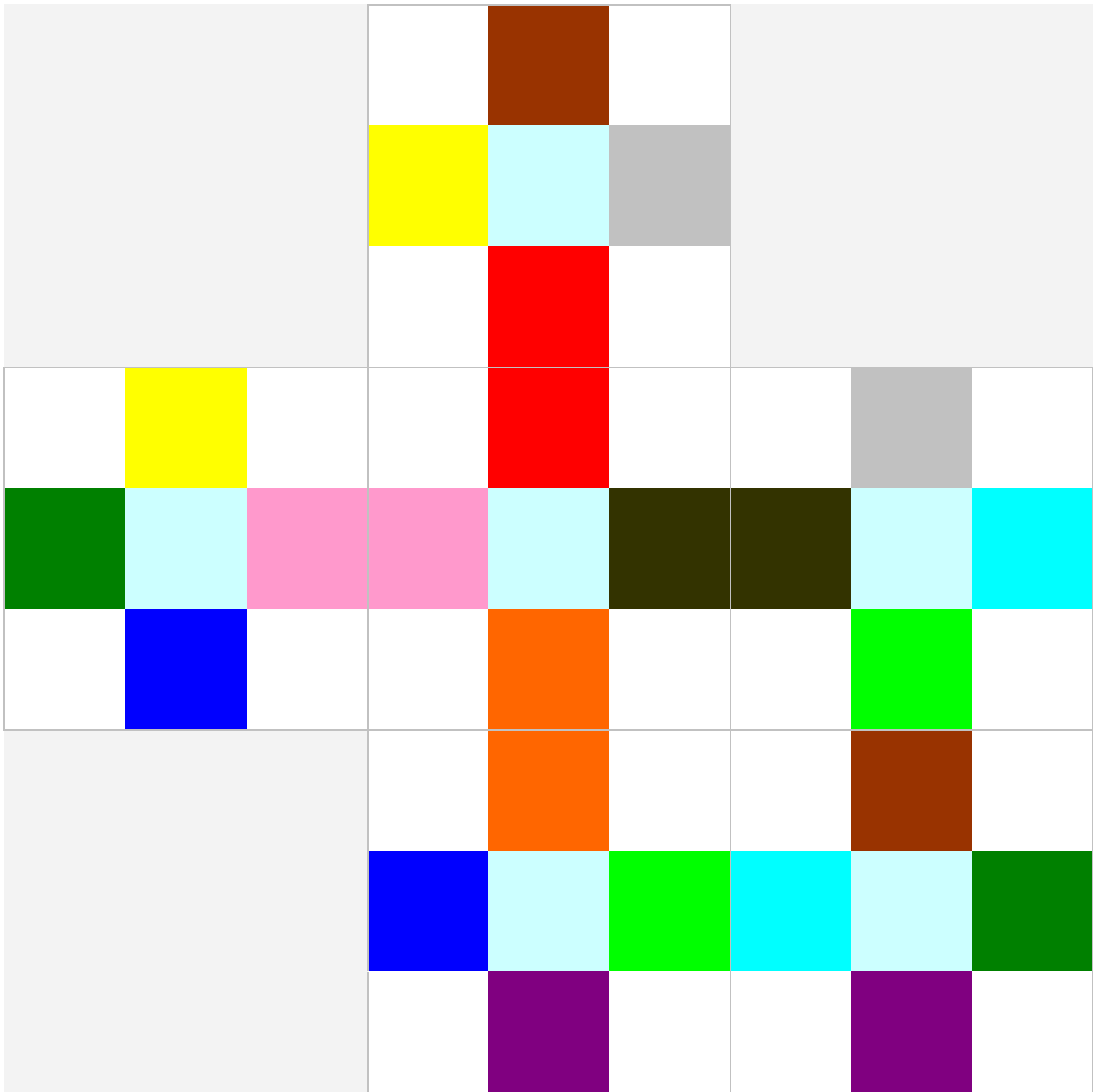
## Corner Cubes Final Check

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).



## 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).



# 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.

