Flight Instrument Panel Cube Design

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WebSites	http://www.mementoslangues.fr/	http://www.randelshofer.ch/

Introduction

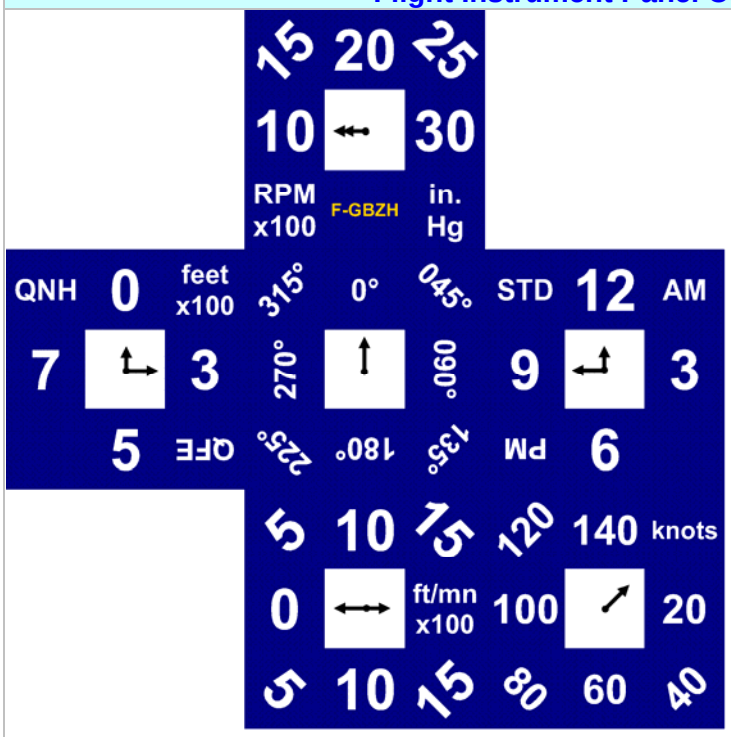
A **Flight Instrument Panel Cube** is a 3x3x3 **Rubik's Cube** used to display some *selected* flying instruments that can be found onboard an aircraft.

Flight Instrument Panel – Useful Links	
http://en.wikipedia.org/wiki/Flight_instruments	http://www.diamondair.com/

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 Flight Instrument Panel Cube is designed by placing letters and numbers on a texture which is then laid down on a Virtual Cube (see http://www.randelshofer.ch/ for more details).

An instrument 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 Instrument Panel Cube. **F–GBZH** is the callsign of an *hypothetical* aircraft based somewhere in Brittany.

Flight Instrument Panel Cube – Callsign Customized	
	
Instrument Panel Cube Texture: F–GBZH Callsign	Instrument Panel Cube: F–GBZH Callsign
Download **CubeTwister** from: http://www.randelshofer.ch/	

Designing a Flight Instrument Panel Cube that *works* is definitely not a trivial task but **Design Rules** exist that should be applied. Because it is nearly impossible to test all configurations, the placement of numbers and letters on a texture should be carefully checked at *the end* of the design process. This is carried out by applying a **Design Rules Check** (**DRC**) in the final design stage.

Typical Flight Instruments

Altimeter

Air Speed Indicator

Heading Indicator

Directional Gyro or Gyro

Vertical Speed Indicator

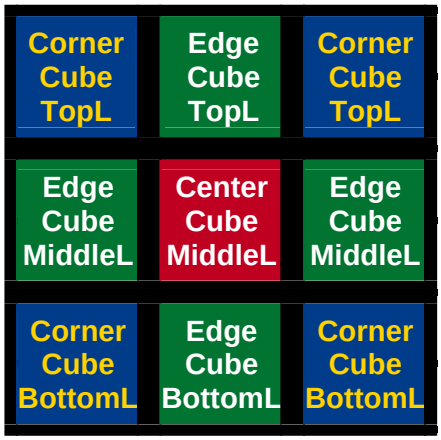
Variometer

"Basic T" Standardized Arrangement

Six basic instruments in a light twin-engine airplane arranged in the basic-T. From top left: airspeed indicator, attitude indicator, altimeter, turn coordinator, heading indicator, and vertical speed indicator

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

Altimeter Setting

The aircraft altitude is measured by an Altimeter, which is one of the most important flight instrument on board. This instrument needs a *reference* pressure level, because the number displayed on the instrument is a *relative* number, not an *absolute* number. There are 3 reference settings that can be displayed on an Altimeter:

1- **QFE** (**Q**uebec **F**ox **E**cho or **F**ox **E**cho): the displayed number is the *height* of the plane above a *local* airport.
2- **QNH** (**Q**uebec **N**ovember **H**otel or **N**ovember **H**otel): the displayed number is the *local altitude* of the plane, which is the height **A**bove local **M**ean **S**ea **L**evel (**AMSL**).
3- **STD** (**ST**andar**D**): the displayed number is the *altitude* of the plane, referenced to a *world-wide* fixed pressure datum of 1013.25 hPa, the *average* sea-level pressure. If the displayed altitude is 7500 feet, then the plane is flying at *Flight Level* 75.

Units

There are many units on an instrument panel. Here are some examples:

1- Altitude in feet (ft): 1 foot = 304.8 mm
2- Indicated Air Speed in knots or kts: 1 knot = 1 Nautical Mile (NM) per hour = 1.852 km/hour
3- Manifold Pressure in inches Hg or in. Hg: 1 in. Hg = 33.86 hPa (1in. = 25.4 mm)
4- Propeller Rotational Speed in RPM: 1 RPM = 1 Revolution Per Minute

Cube Layout

The cube layout is very straightforward, because there are 6 Faces and 6 (+1) instruments. Each instrument is then simply laid on a Face.

In the Initial State, the Cube is *almost* solved, ie the hands may not be the right ones but *nearly* the right ones.

The 6+1 instruments laid on the 6 Faces of a Cube are the following:

1- Onboard clock with AM/PM and STD Time indications
2- Altimeter with QFE/QNH/STD references
3- Directional Gyro (0° – 360°)
4- Air Speed Indicator (knots)
5- Vertical Speed Indicator (ft/mn x100)
6- Propeller Tachometer (RPM x100)
7- Manifold Pressure (MP) Indicator (in. Hg)

The Tachometer and MP Indicators are the same. They differ only by the displayed unit.

There are 6 hands and 3 different types of hands:

1- 4 double-hands (0°,0°), (0°,90°), (0°,180°), (0°,270°)
2- 2 single-hands (0°), (45°)

Each single- or double-hand can be 90° rotated.

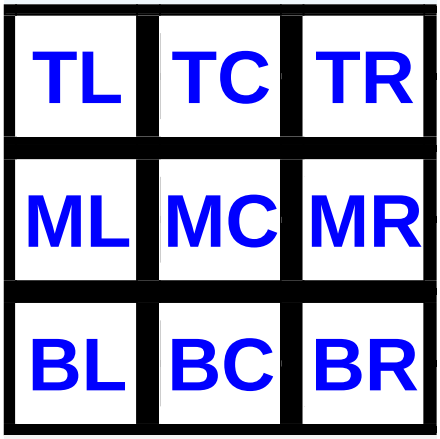
Double-hands are used for the Clock and Altimeter, whereas single-hands are used for other instruments.

Altimeter and Clock should be placed on 2 *opposite* Faces of the Cube. By doing so, they can then share the same 'STD' and 'blank' faces in the solved state *and* have 'QNH' and 'STD' displayed **TL** in the initial state.

There is also a provision for customizing the Cube, simply by laying down a text or logo on a blank edge cube.

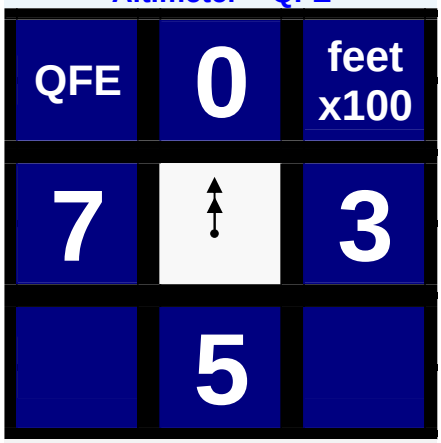
Flight Instruments – Examples

Cube Notation



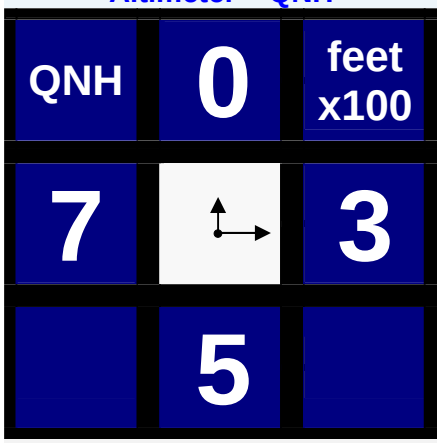
Top, Middle & Bottom Layers

Altimeter – QFE



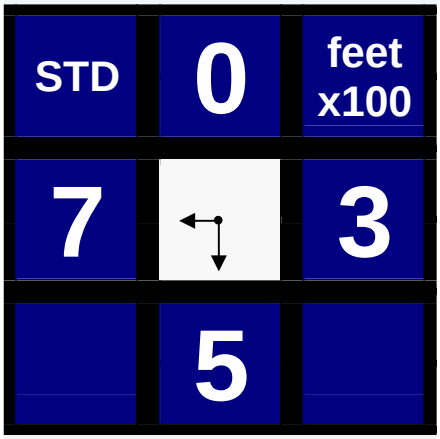
Airport Level: Height = 0 ft

Altimeter – QNH



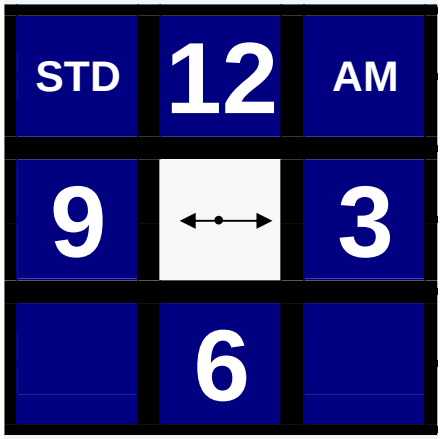
Airport Level: Altitude = 300 ft

Altimeter – STD



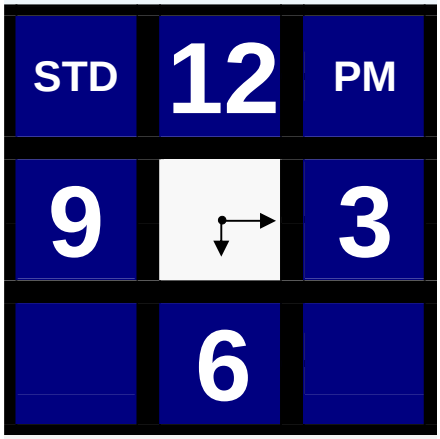
Flight Level: FL 75

Clock



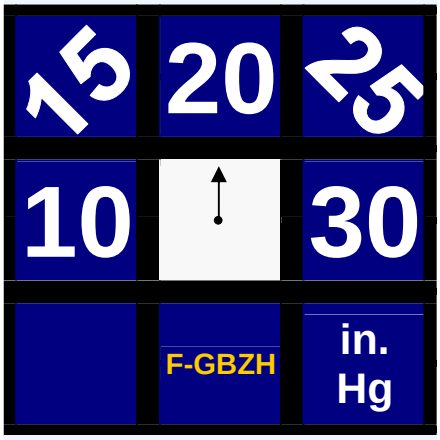
Time: 09h15 AM STD (UTC+0)

Clock



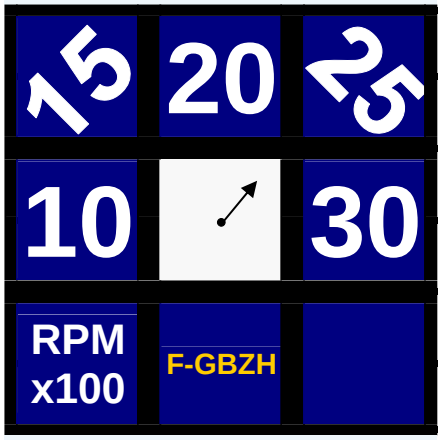
Time: 06h15 PM STD (UTC+0)

Manifold Pressure Indicator



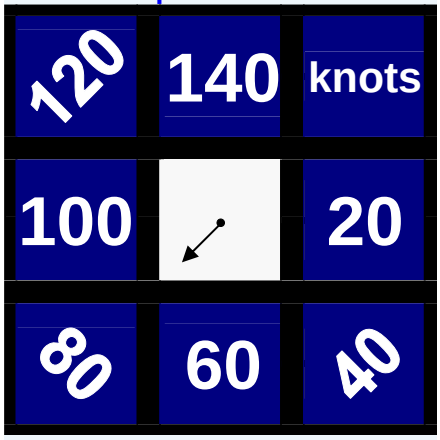
Manifold Pressure: 20 in. Hg

Tachometer



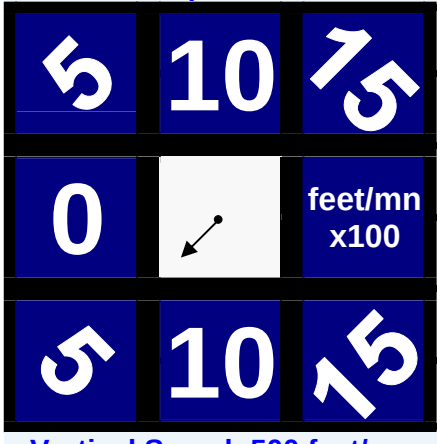
Propeller: 2500 RPM

Air Speed Indicator



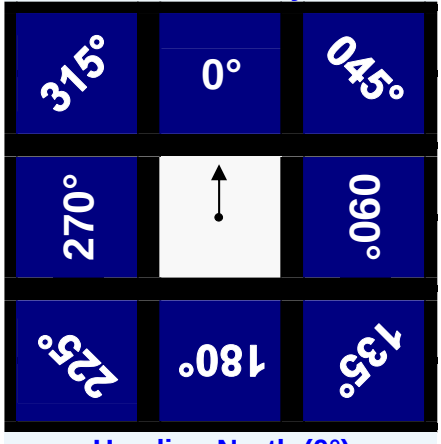
Indicated Air Speed: 80 knots

Vertical Speed Indicator



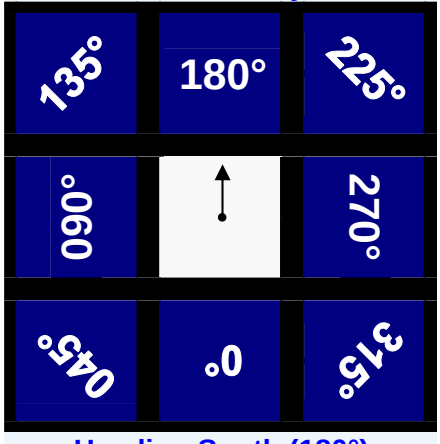
Vertical Speed: 500 feet/mn

Directional Gyro



Heading North (0°)

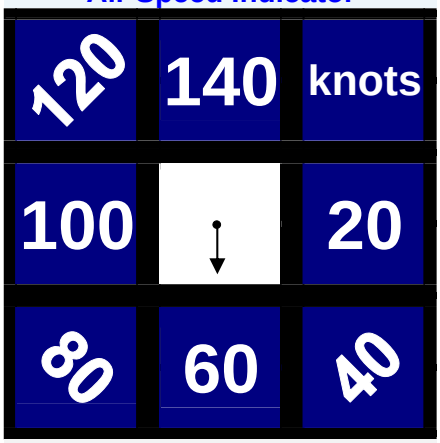
Directional Gyro



Heading South (180°)

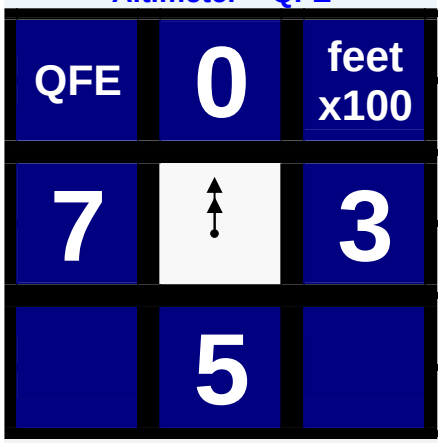
Flight Phases – Taking-off

Air Speed Indicator



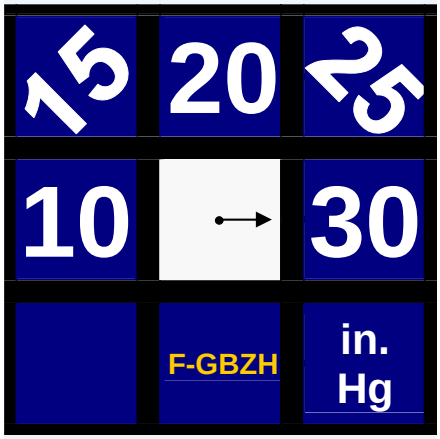
Take-off at 60 knots

Altimeter – QFE



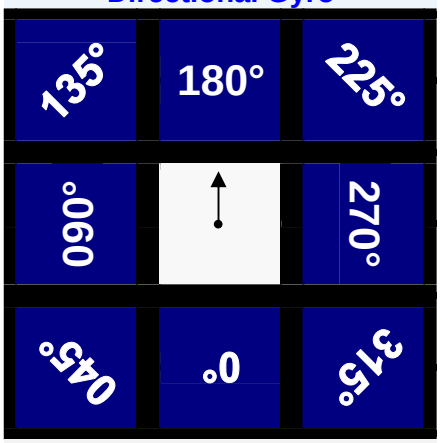
Aircraft just above runway

Manifold Pressure Indicator



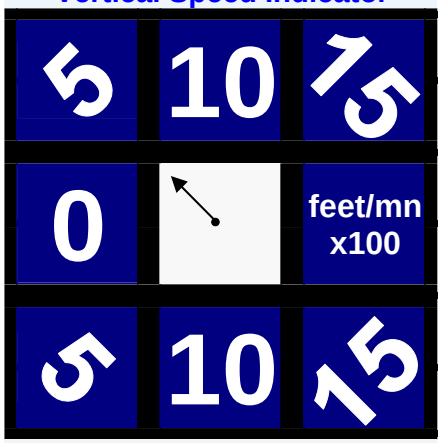
Max. manifold pressure

Directional Gyro



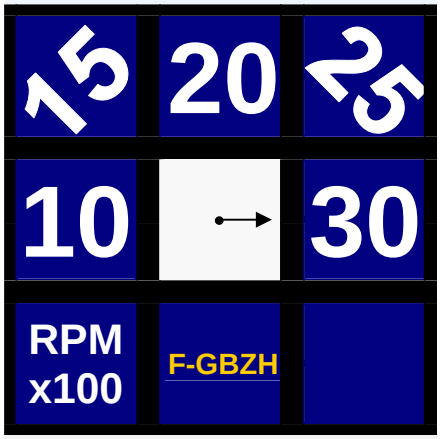
Runway QFU: 18 (180°)

Vertical Speed Indicator

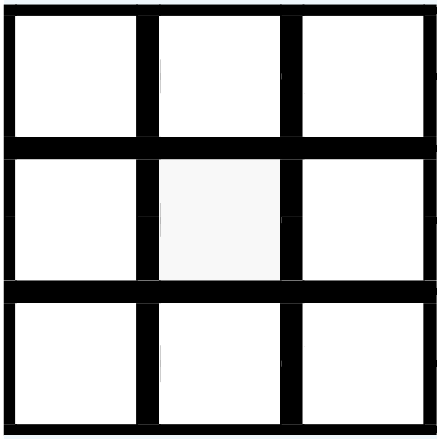


Climbing at 500 feet/mn

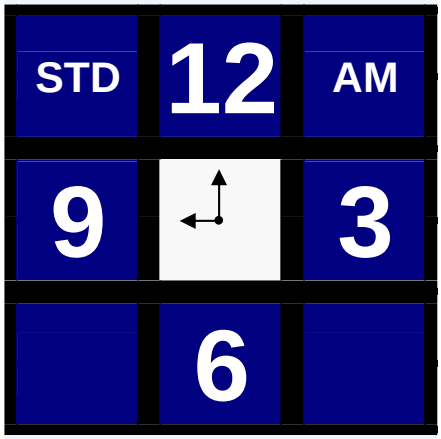
Tachometer



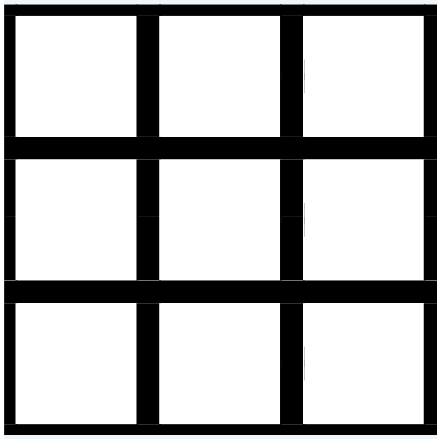
Max. rotational speed



Clock

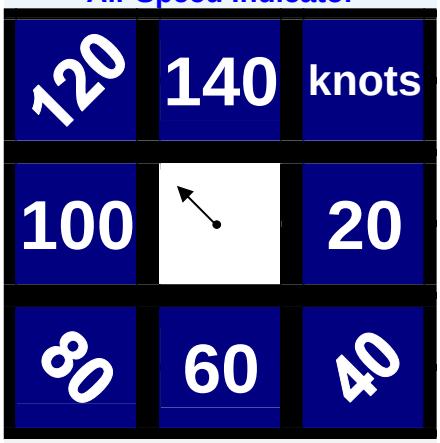


Taking-off at 9:00 AM STD



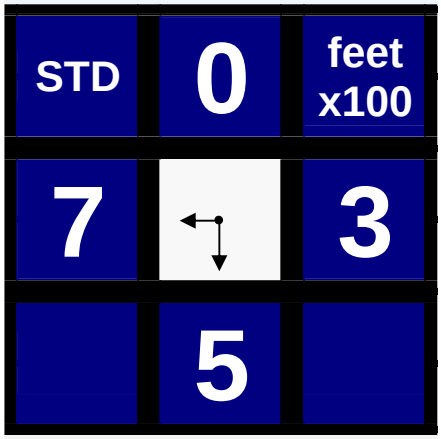
Flight Phases – Cruising

Air Speed Indicator



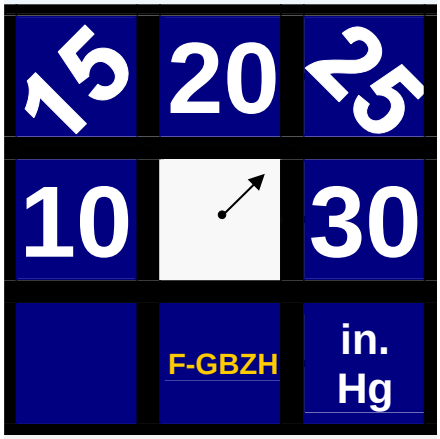
Cruising at 120 knots

Altimeter – STD



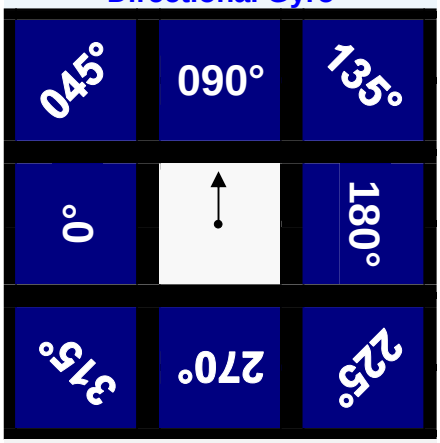
Flight level 75 (7500 feet) STD

Manifold Pressure Indicator



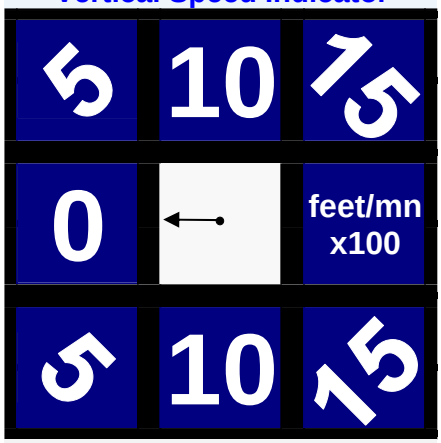
Cruise manifold pressure

Directional Gyro



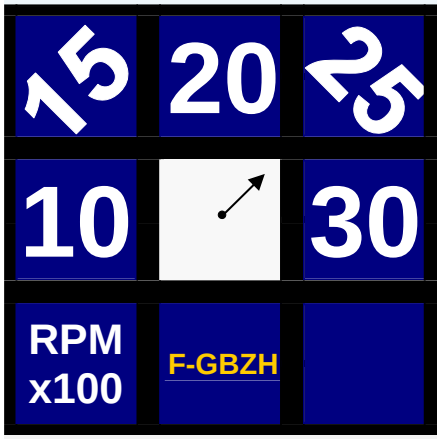
Heading East (90°)

Vertical Speed Indicator



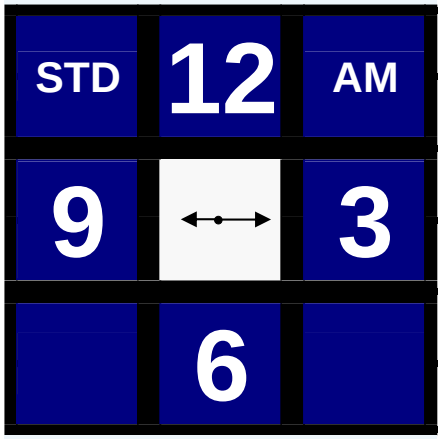
Cruise vertical speed: 0 ft/mn

Tachometer



Cruise rotational speed

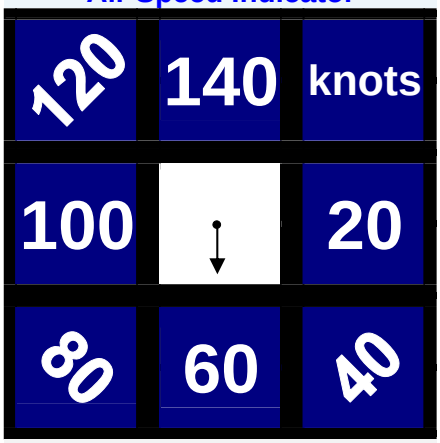
Clock



Cruising at 9:15 AM STD

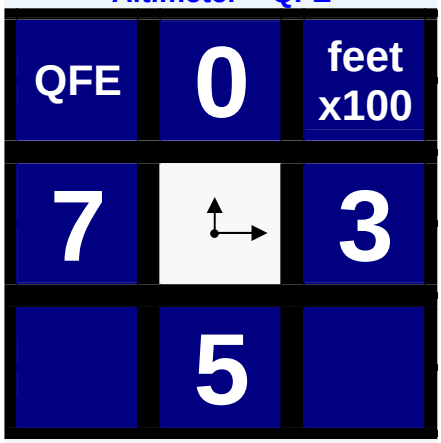
Flight Phases – Landing

Air Speed Indicator



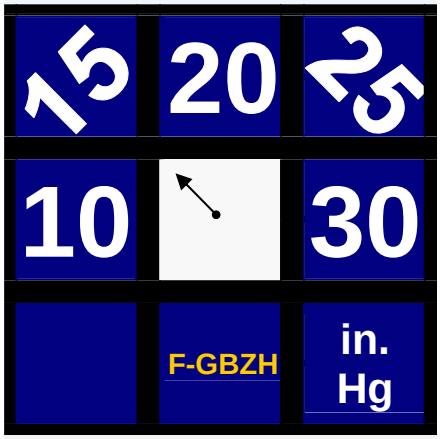
Landing at 60 knots

Altimeter – QFE



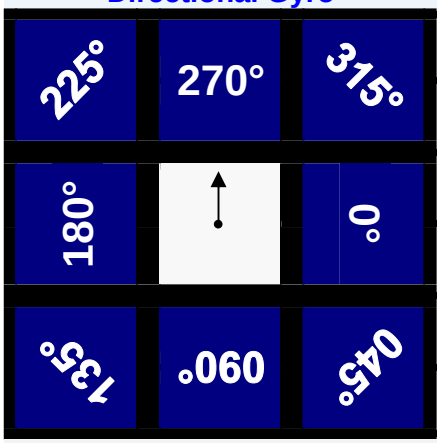
300 feet above runway level

Manifold Pressure Indicator



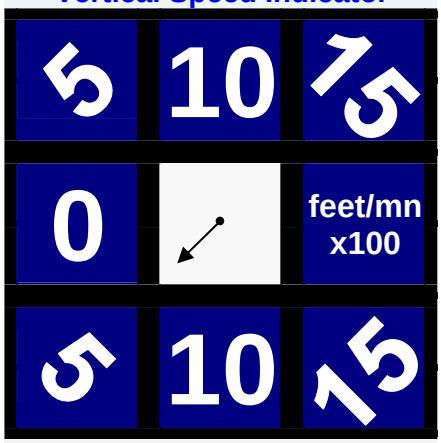
Landing manifold pressure

Directional Gyro



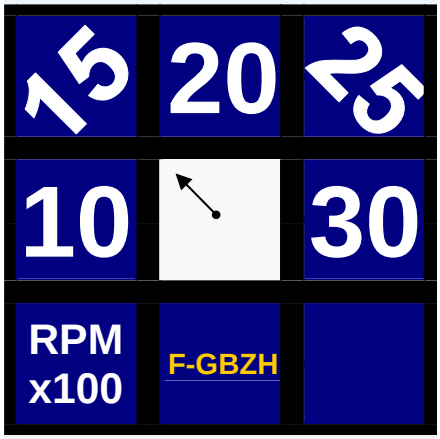
Runway QFU: 27 (270°)

Vertical Speed Indicator



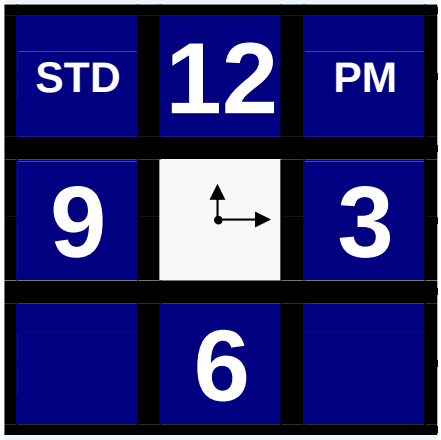
Descending at 500 feet/mn

Tachometer



Landing rotational speed

Clock

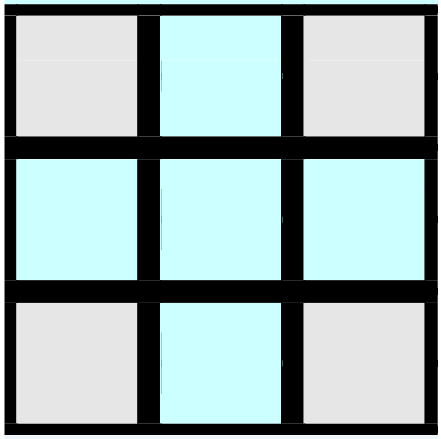


Landing at 12:15 PM STD

Solving a Flight Instrument Panel Cube Step by Step

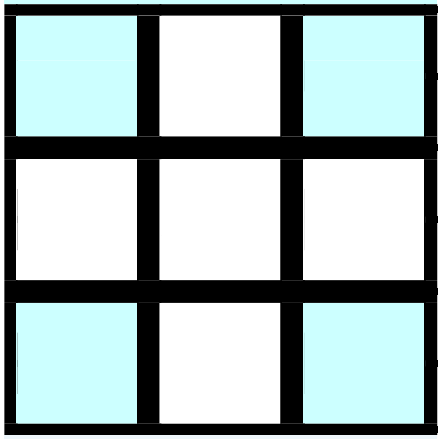
In this example, a step by step solving process is applied to the Flight Instrument Panel Cube, just described before. Note that we only need to solve a *single* Face out of six. We will solve a Face for the Altimeter setting at 300 ft QNH (300 ft Above Mean Sea Level).

Solve the Cross First



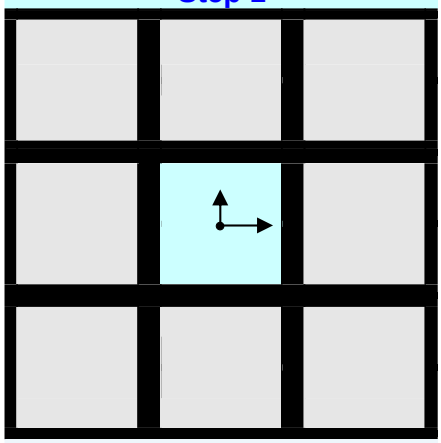
Standard Rubik's Cube Solving

Then Solve the Corner Cubes



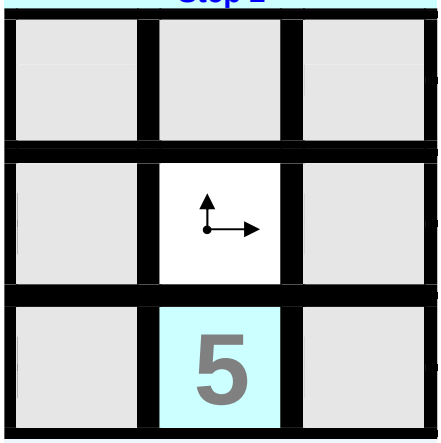
Standard Rubik's Cube Solving

Step 1



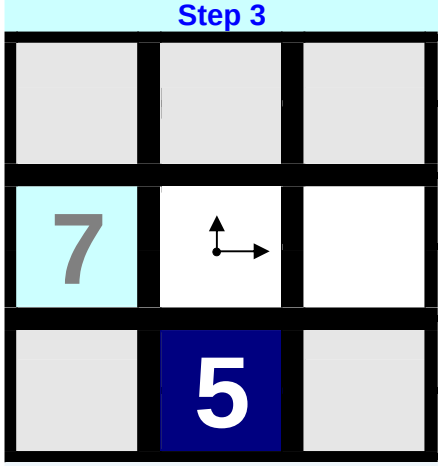
Center 'Hands' on Front Face

Step 2



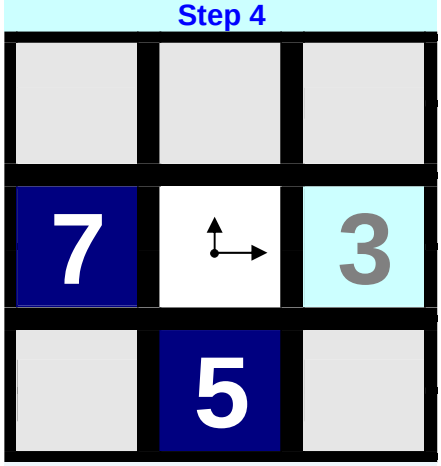
Bottom Layer: Edge Cube 5

Step 3



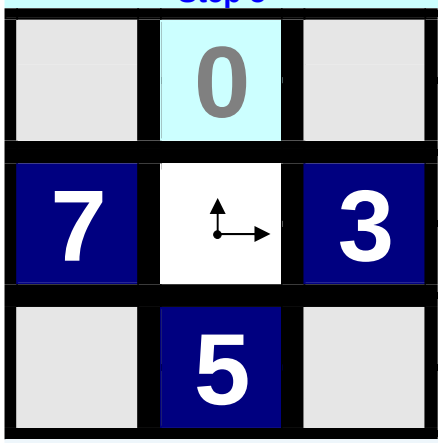
Middle Layer: Edge Cube 7

Step 4



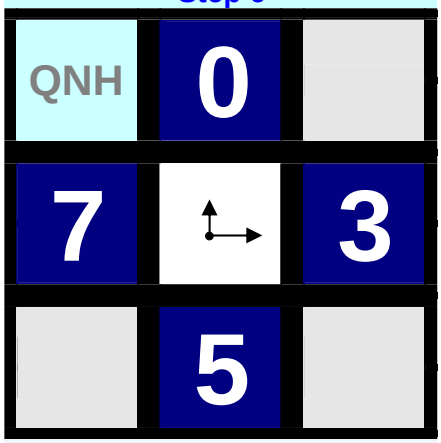
Middle Layer: Edge Cube 3

Step 5



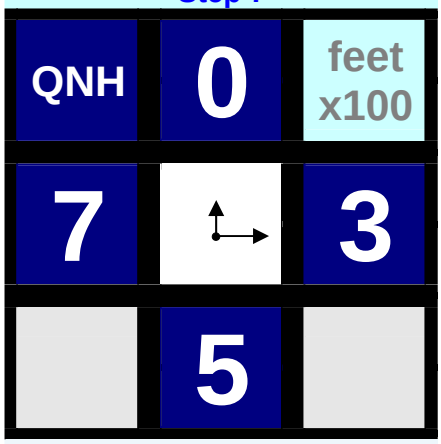
Top Layer: Edge Cube **0**

Step 6



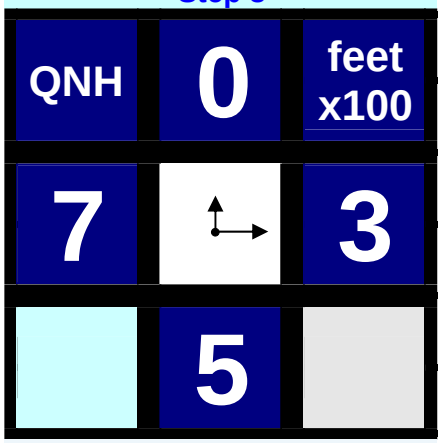
Top Layer: Corner Cube **QNH**

Step 7



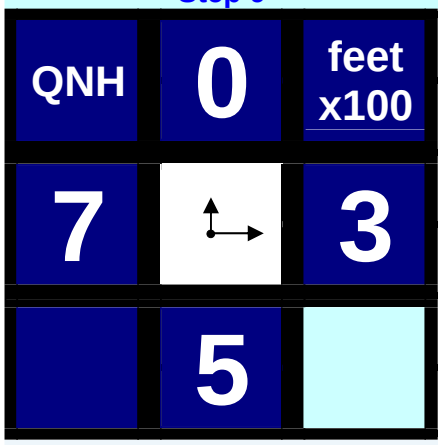
Top Layer: Corner Cube **feet**

Step 8



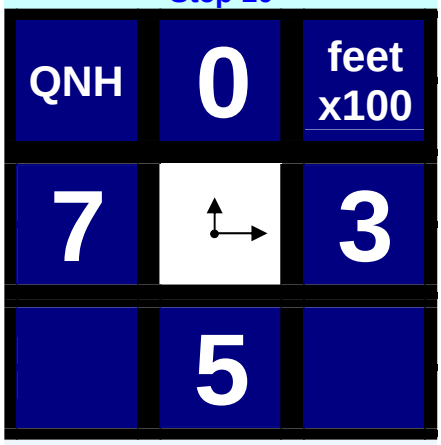
Bottom Layer: Corner **Blue**

Step 9



Bottom Layer: Corner **Blue**

Step 10



That's it !

Print out this page and fill in the blank faces with *your* data. Then try to design your *own* Cube.

TL	TC	TR
ML	MC	MR
BL	BC	BR

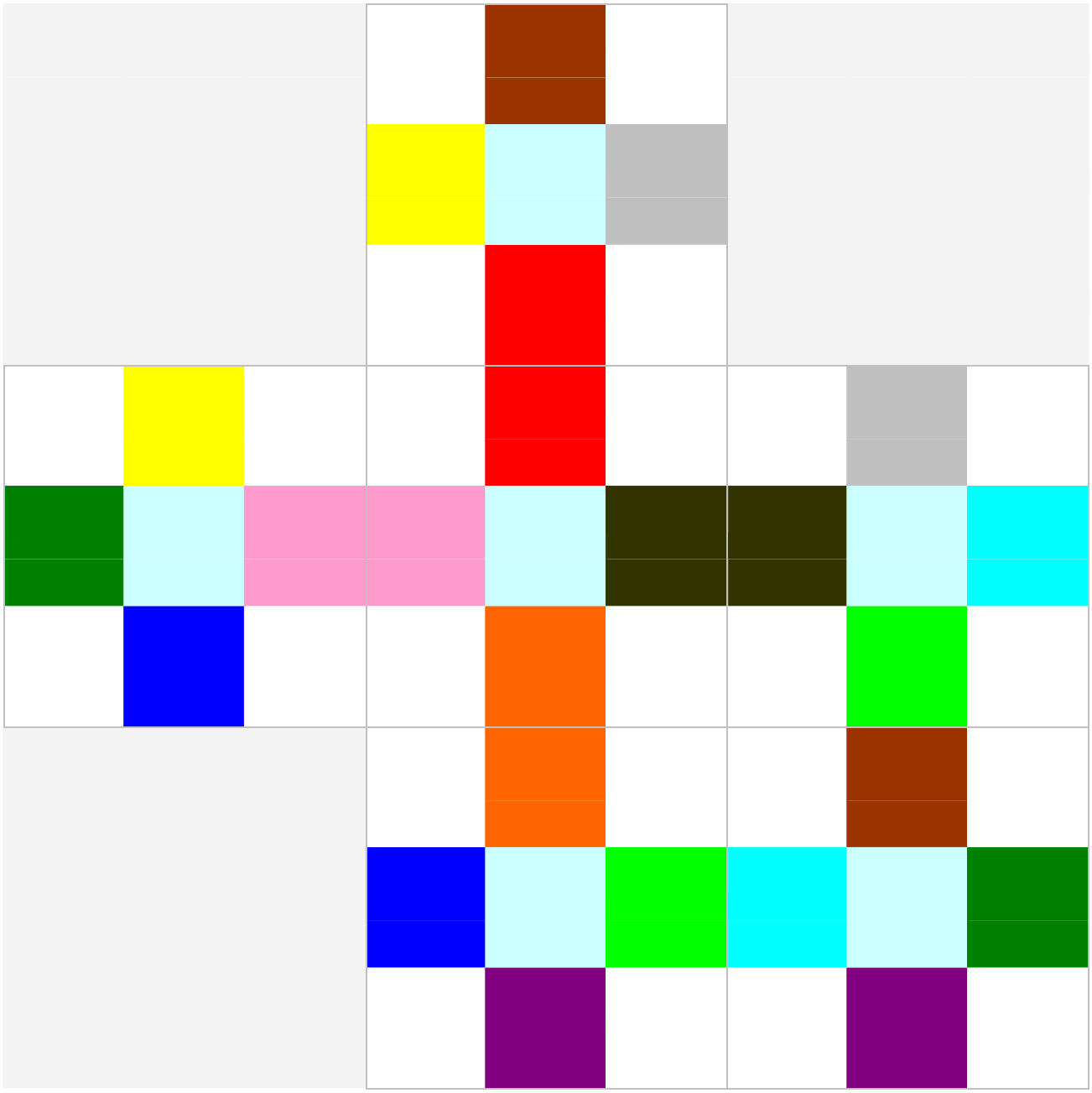
Corner Cubes Final Check

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

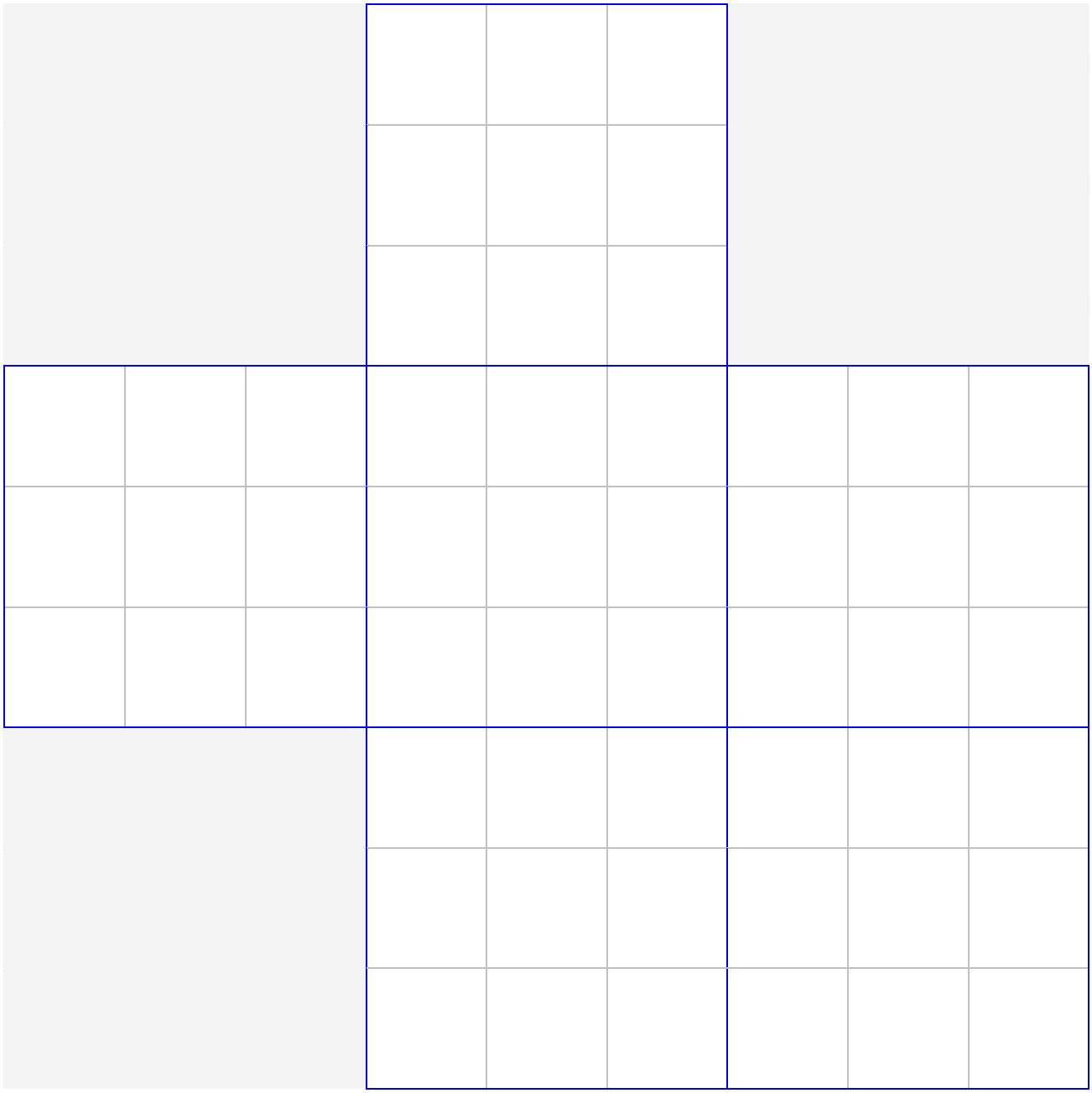
There are 12 Edge Cubes and 2 faces per Edge Cube. In the diagram below, each Edge Cube is displayed in 12 different colors and with the same color applied to each of its 2 faces. This diagram can be used as a convenient *visual aid* to check Design Rules (DRC).



	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.



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