

# Coloring by Numbers

By Steve Smith



*"The beautiful is a manifestation of the secret laws of nature...  
When nature begins to reveal her open secret to a person,  
he feels an irresistible longing for her most worthy interpreter, art."*

- Johann Wolfgang von Goethe- early color theorist

*"The universality of Number can be seen in another, more physical context. We learn from modern physics that from gravity to electromagnetism, light, heat, and even in what we think of as solid matter itself, the entire perceptible universe is composed of vibrations, perceived by us as wave phenomena. Waves are pure temporal patterns, that is dynamic configurations composed of amplitude, interval and frequency, and they can be defined and understood by us only through Number. Thus our whole universe is reducible to Number."*

- Robert Lawlor, *Philosophy and Practice Sacred Geometry*



## Introduction

The universe is built from vibration - sound, light and geometry. They are the elements of art and music. It appears there are certain universal principles regarding form. Spiraling invisible energy, Platonic solids, octaves of color and sound, mathematics and numbers.

Geometry has a power to gather energy in ways we can explore. Architecture is one area that has explored this through the ages – the pyramids, the renaissance cathedrals, geodesic and domed structures. Some of these ways are inextricably tied to religion. Some are tied to sacred art – the mandala, the cross, archetypes. Many of these powerful elements are being discovered through science on a way to understanding the power and structure of the universe.

Numbers are the basis of mathematics and counting. They are universal, being used by all men in their daily lives. By visualizing number systems, I turn the abstract idea of counting into a picture. I materialize a pre-ordained arrangement.

I have realized that counting is a fractal principal. It has repetition, self-similarity, iteration, and infinity. Counting may be the earliest fractal man ever invented. It has been latent in the face of mathematicians and science for ages. Fractals themselves are systems for creating designs, patterns and forms. I feel it is time to explore counting's multi-dimensional ramifications. I am not particularly interested in numerology, but those number patterns might be revelatory as well.

Counting can be expressed through color and other variables as well. Simply assign a variable to a number and count to get periodic, infinitely variable structures. When imposed on grid surfaces, including platonic and sacred geometry, these structures can be explored. By assigning color to number, I have been exploring and searching for new dimensions and dimensional crossovers. I am also pursuing the beauty, synchronicity and coherence of number systems in my art.

## Coloring by Numbers (CBN)

CBN mixes fundamental mathematics with fundamental geometry as it manifests color fractals. CBN is a methodology for patterning regular geometric structures with counting. Colors are mapped to numbers which array linear pattern sequences on grids. Counting is a numeric fractal which iterates and scales to infinity. Patterns are created through repetition and scaling as counting evolves and adds to itself. These sequences could also be manifested in temporal arrangements to create audio and video.

Utilizing simple counting with colors on grids, I can program a computer to graph the resulting patterns. I can also do this directly with physical media, turning my canvas (or other media) into a sort of computer for patterns. The results are predetermined after the initial choice of colors. However, there is an incredible freedom in choosing the colors, the number base (also number of colors), the way they are arranged and on what surface structure they are arranged, and the media to express this patterning through. The resulting pattern spreads magically to the surface and inundates it with the visual manifestation.

Note: there is no requirement to count forwards or to start with 1.

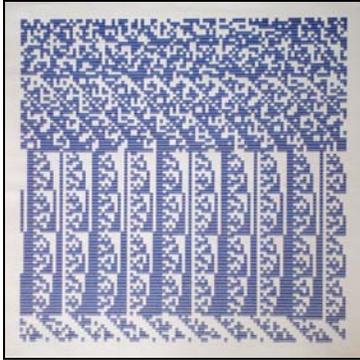
Make your own rules. Use numbers however you want to. Maybe the Fibonacci sequence, maybe primes, primes backward, ...



CBN Painting Base 8 Octagon, 1 to 1000, Blended, 2011

## Number Bases:

You can count (colorize) in various number bases depending on how many various elements you would like to work with. Base 10 uses 10 colors, Base 2 uses 2 colors, etc.



Early Pen Plot Base 2 sequential digits, 1979.

Number bases can be utilized to limit the seeding of the pattern to a certain palette of possibilities. Using variable number bases allows a great flexibility to this system. Grid elements can easily include other structures than just color. I have created patterns from counting with letters in base 26 (the alphabet) that include all possible words (as well as all unused letter combinations) from that alphabet – pretty cool.

For clarity, I am talking about counting in other number bases other than our familiar base 10. Digital base 2 is an obvious example, but for all readers whose math is fuzzy in this esoteric area, it goes something like this: Counting in base 4 would have us think of 3 as we would 9, only 3 would trigger the next threshold of counting. 9 is the end of a sequence of 10 – don't forget about zero as a digit – the most improbable of numbers. Base 4 has 4 colors (elements) representing the digits 0, 1, 2, 3. Let's look at this as a sequence of numbers:

1 2 3 10 11 12 13 20 21 22 23 30 31 32 33 100 101 ...

And now as a sequence of digits:

1 2 3 1 0 1 1 1 2 1 3 2 0 2 1 2 2 2 3 3 0 3 1 3 2 3 3 3 1 0 0 1 0 1 ...

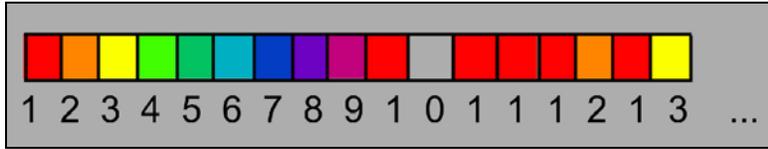
These create 2 linear possibilities of counting with colors –

- 1.) Blended colors from the mix of the digits of the numeral or
- 2.) Sequential digits, i.e. If red represents 2 and blue represents 1, 21 could be represented by red following blue (sequential) or by mixing red and blue in even quantities, yielding purple(blended).

**Thus 2 main structures for coloring:**

Let's look at these 2 counting backwards:

**2. Sequential digits resulting from the count:**



My first explorations with Coloring by Numbers quickly led to a partnership with Jeff Yetter (Hewlett Packard) who assisted me in programming early Unix machines to create counting patterns in 1979. I had created numerous hand drawings and had been using a limited number of colors in a certain number base. With this approach the exact number of colors picked to count with are in the final output and only those colors. Each color chip (or grid unit) represents a digit of a number before it and followed by the digit after it in a sequence without any visible separation.

This was an excellent match for a pen plotter; which was the only available high resolution output at the time, considering raster graphics was at its infancy (mostly black and white).



Example of Early Pen Plot – Arrangement reads like a book, 1980.

**1. Blended numerals from digits:**



Number counted to is represented by blended digits – Color 13 equals even quantities of 1 and 3 on one color chip (grid element). This generates mostly new colors as we count. Some remain the same – 123, 231, and 321 are the same blended color.



Example of blended colors, Acrylic on Canvas, 2011.

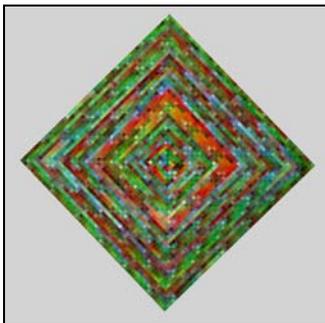
### Grid structures and arrangement on grid surface:

I am launched into an exploration of grids by necessity when creating a static image representation of counting patterns. Temporal exploration without grids is, of course, another possibility. So is the pursuit of individual, subtle color mixing through counting.

Visual representation creates physical limits on grids. Therefore grids can give birth to larger, conceptual grids as they expand towards infinity. CBN allows the co-creation of divine patterns. We can explore the pre-conceived by birthing our own arrangements and color choices on grids. Linear number sequences could read like a book, wrap around themselves in spirals, read left-right/right-left, array in plaid form or move through 3D space (or whatever we decide).

### Square Grids:

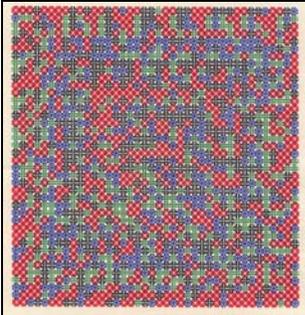
Square grids are the most commonly known grids. They are implicit in 2 dimensional coordinate systems. They were the first I explored. I quickly decide to spiral from the center as it easily implied the continuity on the grid to infinity.



Acrylic Painting on Canvas, Blended colors, 1990

### Pattern by Numbers:

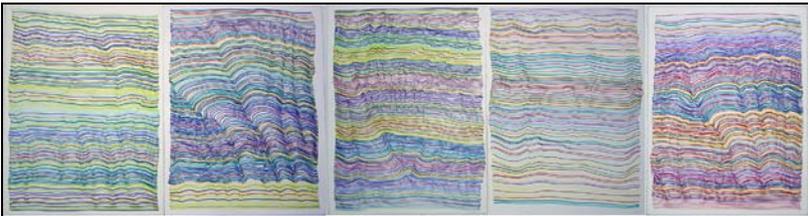
Rather than just a color, a pattern and a color can be applied to the grid. There are infinite possibilities here as well.



Pen plot – Pattern by Numbers Series, 1980

### Lines and Plaids:

Sequences of lines can be used in counting. This has worked well for weaving and simple drawings. There are infinite variations on this theme alone, considering the variables of color choice, number bases, and range of counting activity (what number you start and end with).



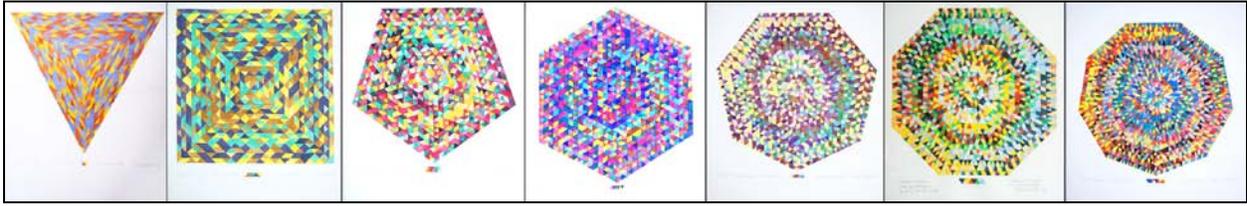
5 Drawings – Pen on Paper, 1988.

Another logical use of square grids with a linear sequence is to create plaids by repeating the sequence as horizontal and vertical line sequences combined.



Pen plot – Plaid Waves Series, 1980

## Polygonal Grids:



Watercolor series for Master's Thesis - Base 3 triangle, base 4 square, base 5 pentagon, base 6 hexagon,....., 1982

Polygonal grids were inspired by the tessellation geometry and optical illusions. These grids unfold towards infinity. Continuing the patterns beyond the viewing surface, the viewer can mentally continue the pattern (with some effort). This implied continuation infers and compels the infinite expansion that is possible. Polygonal grids can subdivide most any polygon and that is another realm of possibilities.

Most of my explorations of CBN involve grids wherein I begin from the center and spiral outward, usually clockwise. CBN spirals usually represent the inception of an infinite field of patterned colors (radiating outward) - limited by the edge of the grid.



Color and Pattern by Numbers Pen plot – Folded Poly Series, 1980



Tessalating CBN pen plot with colored pencil – Plaid Waves Series, 1980

*“Through objects we are in touch with the finite. Infinity is implied in these structures as the continuity and fulfillment of what is predefined. The earth and its wonders are finite, but we are constantly teased with infinity. The number of trees in a forest – all forests; the number of grains of sand at a beach – all beaches; the number of rocks – all rocks on earth – all in the universe. There are infinite possibilities that exist. “*

- Steve Smith, 2011

### **Choice of media:**

Media choice adds another arena of variables for CBN. Colors, patterns, images, audio or video bits can represent the digits of the numbers or can be mixed to represent complete integers. Click on this file for an example of audio CBN. My apologies to Julie Andrews and the Sound of Music.

do me me re so so.mp3

Though using a computer is more accurate, pleasing patterns can be created with colored pencils on graph paper or with grid-based media such as mosaic tile, weaving, hook rugs, and needlepoint. Many modular systems and tessellations are ripe for this kind of patterning.



**Glass Mosaic Color by Numbers Pyramid , 2011.**



**Color by Numbers Weaving Base 8, 2011.**



**Color and Pattern by Numbers Needlepoint, Base 10, 1985.**



**Color by Numbers Hook Rug - Base 10, 2011.**

One of the major media I have used to explore CBN is Computer Graphics.

*“To assert that computer assisted art is not art is as absurd as saying that computer assisted music is not music.”*

- Steve Smith, 1982

## Computer Graphics:



Color by Numbers Screen Photograph – Early Raster Graphics, 1982.

Utilizing simple mathematics, I can program a pattern into traditional media. The color choices act as a seed to the overall design and, pre-ordained, dictate the final outcome. Through ideas meaning can be added to abstract art. The beauty of the structure of nature can be analyzed, appreciated, and re-approximated.

Objectifying art into systems (systemic art) can minimize spontaneity and expression. A certain diligence is required to execute drawings of systemic structures. One factor for me is keeping count. These factors open the door for the use of a computer to execute the final drawing. Computers are precise, consistent, versatile, accurate and tireless. They cannot be ignored as valid tools for visual artists. With their use comes a certain loss of individuality and a denial of handcraftsmanship, but computer graphics has the potential to map realities that go beyond human capability (by hand). The drawing below is a good example of the accuracy that would be impossible manually.

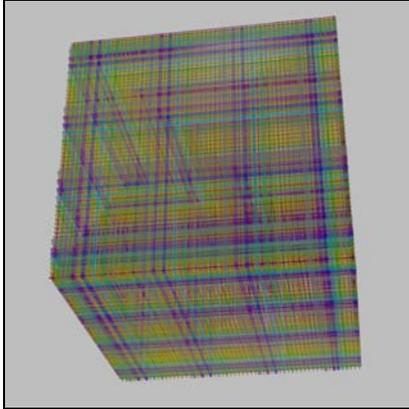


Color by Numbers Pen Plot – Plaid Waves Series, 1980.

My work with pen plotters using 3D grids in perspective (Splash series) is an illustration of an impossible task for the human hand to execute. It would not be possible for even the best draftsman to execute these drawings. The computer can execute this work with a speed and perfection which is alarming.

Perfection becomes the norm. One program can be used to create endless variations on one idea or arrangement, with minimal time and effort. Just seed the chart and let it go (see the screensaver software at <http://www.arttoyz.com>). The work of art is de-mystified at the same time it is revealed as divinely inspired. Human skill is evident not in the skill of execution or expression, but in the structure, concept and color choices. Technical and scientific tools are used to create art – geometry, computers, mathematics, trigonometry and programming. Computers continue to expand the possibilities of art and will continue to indefinitely. 3D graphics and animation are areas of my recent exploration.

Computers allow us to re-create the physical world.



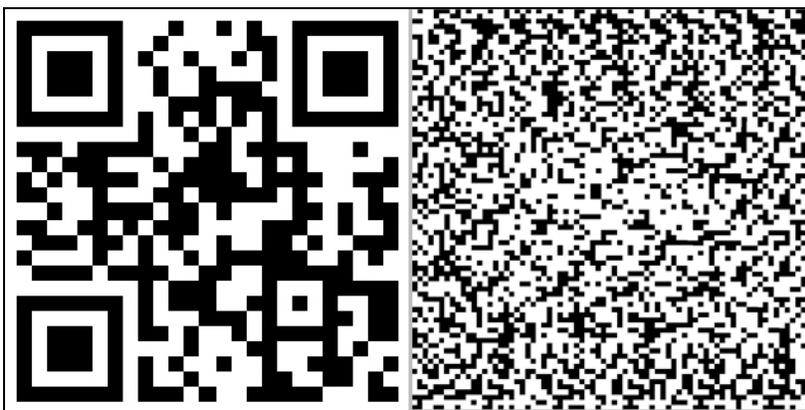
Still from 3D Animation – Cube Plaid Series, 2011.

### CBN for Science:

CBN is a regulated, apparent random, way of mixing colors. This can be used to chart subtle variations in color mixing, including all (actually this is infinite) possible mixing of any set of colors. Out to infinity, any subtle layer can be analyzed by zooming in on that numeric section of the counting pattern. The application for color matching and paint mixing are some of the arenas of possibilities. Existing colors can be matched with only a certain, limited number of source colors. An example would be a paint store that is out of a certain base pigment. Perhaps there is an available substitute – the exact proportions of the existing pigments just need to be determined.

CBN simulates randomness with user controls available at many levels. Numbers can be charted and reiterated with a seeming randomness. This could have many scientific and other useful ramifications. It could augment or replace a scientific dependence on random number generation and add a stable, chartable substructure. This could add incredible tracing of current random intervention into systems.

QR (Quick Response) Codes are a new phenomenon. Perhaps CBN could yield color variations with multiple levels of information concurrently. This idea was aroused by the fact that QR codes remind me of my early CBN explorations.



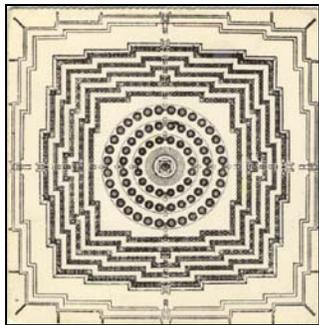
Left: QR code for ArtToyz.com, 2011; Right: CBN base 2 from Visual basic program, 1999

Perhaps there are unrealized applications to science and other fields. I invite readers to pursue any ideas along these lines and I would be glad to assist in such undertakings.

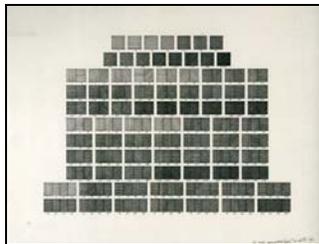
*What is God? He is length, width, height and depth.'*  
- St. Bernard of Clairvaux, *On Consideration*

### **Sacred Geometry and Artistic Influences:**

CBN influences include a mixture of science, art and religion. Some of my artistic influences for CBN include sacred, Tibetan Art – Yantra and Mandala. M.C. Escher's grid studies from the Alhambra were a major influence on my conception of periodic, triangular grid structures. The 60's spawned many ideas: Conceptual Art (Sol LeWitt), Op Art (Victor Vasarely) and Blacklight (Dayglo) Art. Note that most of the paintings I have done in the last few years mix blacklight pigment with regular pigments to create gradations of blacklight effects. This expands beyond the traditional colors that can be reproduced through printing, computer graphics or photography as they are outside the gamut of RGB or CMYK.



Mandala, from Google image search

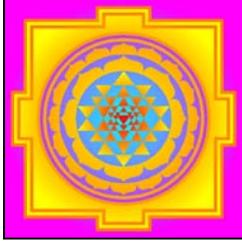


Sol LeWitt, *All Single, Double, Triple, and Quadruple Combinations of Lines in Four Directions One-, Two-, Three- and Four-Part Combinations (for Center Spread/Art and Project)*, 1969



Victor Vasarely, Circa 1970, from Google image search

CBN can be used as a Yantra for meditation. "Yantra (यन्त्र) is the Sanskrit word for "instrument" or "machine". Much like the word "instrument" itself, it can stand for symbols, processes, automata, machinery or anything that has structure and organization, depending on context." - Wikipedia



Sri Yantra, from Wikipedia

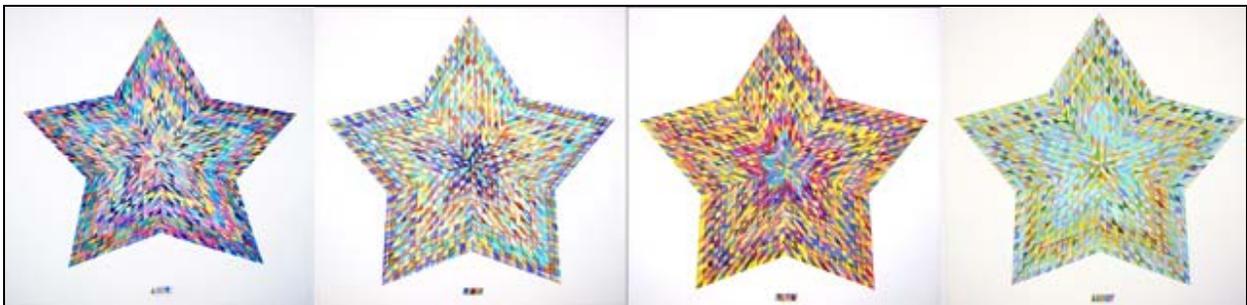
– Note the vibrations and eye-wandering in the center triangles.

I am currently exploring octaves and harmonic structures. Digits = Colors = Chakras = Root through 7 levels. Vibration relationships and scales of colors are being explored with subtle filtration and mixture. My goal is to seek coherence in the patterning.

Obviously the artistic variables are endless. CBN is multi-dimensional. Colors individual properties fit together with natural weighting toward coherence. Perhaps we can materialize harmonic structures and scales – such as music utilizes. Color vibration is just like notes – but faster. Please help me explore these new realms.

Consider visiting <http://www.arttoyz.com> for free software and images. All software and images are free of charge and copyright restrictions. Collaboration and creative use of CBN are welcomed.

Steve Smith 1/2012



Watercolors – Star Color by Numbers series, 1982

**Links:**

<http://www.ArtToyz.com>

<http://www.sacred-geometry.com/index.html>

<http://www.geometrycode.com/sacred-geometry/>

[http://www.spiraloflight.com/ls\\_sacred.html/](http://www.spiraloflight.com/ls_sacred.html/)

<http://crystalinks.com/>

<http://www.sangraal.com/>

<http://www.people.vcu.edu/~chenry/>

<http://www.charlesgilchrist.com/SGEO/>

<http://www.halexandria.org/dward095.htm>

<http://www.integratron.com/5SacredGeometry/SacredGeometry.html>

<http://www.luminanti.com/geometry.html>

<http://www.drunvalo.net/>