Hardware, Software & Wetware Limits to Populating Infinite Zoos.

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The author, age 8. 18" x 24" Oil on canvas, 1960, P.M.Palmer.

Abstract

I am reporting on 50 years of computer use wherein I have evoked a few algorithms capable of creating infinite visual representations (if funded) of a geometric theme I call '*The Myth of the Eternal Carriage Return' [1]*, or more succinctly, '*Circles: Great & Lesser*'.

A timeline will limn the development of my work that has culminated in the dynamic shading of lattices constructed with simplexes. A 2 minute 47 second animation, "18 Rhombic Dodecahedra" is presented here as an exemplar of this new work.

https://youtu.be/_NdJUWyfJw4

Background

My first code, in APL, calculated chord factors for a geodesic dome in 1973. In 1978 Trim Tab as he wanted to be called (R.B. Fuller) encouraged me to develop my computer skills in order to assist in his great plan to "Make the world work!".

In the 80's I trained with Holguin, Unigraphics and Computervison CAD Systems for use in a laser cutting startup. I was asked to provide patterns for laser cutting and also to evaluate new CAD systems as they became available. Surprisingly every CAD software salesmen I met had no idea how to draw a tetrahedron, let alone knew what one was.

Later for my 1994 industrial design master's thesis, "*Omniopticon*" [2] I prototyped several spherical displays:

1. An icosahedral dihedral kaleidoscope (3 mirrors) attached to a VGA monitor

with a random graphics generator that I had coded in Pascal. Hardware & software multiplied a VGA's image of 300,000 pixels sixty times to create a virtual image of 18 million pixels. What appeared was a dynamic oblate sphere that combined structure and randomness into a coherent whole.

2. For *Omniopticon* I also encoded the C.I.A.s coordinate database of global coastlines, rivers and lakes into an AutoCad DWG file for use in an illuminated geodesic globe. Although I would like to claim this as "I hacked the CIA ." It was public domain!

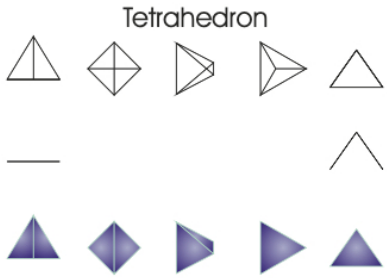
3. *Omniopticon* also predicted multiple micro-mirror device projectors (now DLP projectors) will illuminate dome displays. c.f. Al-Wasi dome in Doha.

Since then I have become a user not a coder. I continue seeking means to visualize synergetic geometry. I am influenced by my software choices.

At school I had used AutoCAD and an ad hoc methodology of '*point & click*' that replaced compass and rule. With it I created my first polyhedral zoo and a luminaire or two.

I sought to colour the spaces between the projected lines of my zoo. I used Corel Draw to convert 3D DWGs in planar projections to 2D *cyclons*, nurbs derived from polyhedra in projection; data-mining of a sort. See the Tetrahedron page below and the cine-cylon '*Rhombic Dodecahedron in Flatland*'.

https://youtu.be/juyZSx_LVW8



This 'Spline Mine' was recently shown to compare closely to lesser circles, i.e. circles coplanar with polyhedral faces that intersect the polyhedrons circumsphere.

c.f. *The Lesser Circles of our Nature. Tetrahedral Symmetries.*

https://youtu.be/rSMsDmJZ8c4

But hardware & software come and go. Leaving a trail of digital scat: SWFs, DWGs, DXFs, SVGs, JPGs, PNGs, TIFFs, MOVs, etc.

What to do with it all? I keep drawing polyhedra with the next best user interface available on a budget so that maybe I can Grok the shadows that appear on the wall of my cave!

Rhinoceros 3D modelling appeared in the millennium and absorbed my polyhedral database. My point & click construction method was revealed to have introduced excessive errors (up to 120 '*Origins*' for an icosahedron). So I converted 27 dihedral simplexes of the Platonic & Archimedean solids to trigonometric functions. I could now draw points, lines, arcs and surfaces with precision. I created '*27 Blue Dihedral Kaleidoscopes*' the movie:

https://youtu.be/e7f2CqiTL4Q

I began to use block data structures and developed an appreciation for transformation matrices. Yet problems with unwanted flicker persisted in a series of path animations that control the motion of a virtual camera: orbits and dive throughs. The flicker was perhaps due to surface orientation which may in turn be caused by the *direction* of surface edges.

I exploited Matroyshka combinations of polyhedra, 3D chords with chromatic

radii. With these I produced more orbits and dive throughs. If surface transparency is used, Necker Cube illusions influence perception of rotational direction. Fix it or feature it?

For orbits and dive throughs see my Trim Tab Tribute: In Out Around.

https://youtu.be/q_NHU6RZWCs

Parametric and Precise.

Along comes Grasshopper the companion to Rhino and finally parametric modelling becomes a reality for me. It has a user interface I can use. Miraculously it seems, my Grasshopper rebuilt dataset's surfaces are properly oriented.

Then in March of 2020, my new computer was fast enough for me to *see* that an angular change to the texture map I used to shade my model would result in a dynamic kaleidoscopic like display.

Immediately I began populating my new zoo. All done without mirrors!

Infinitudes

Most of the cages in all infinite zoos are empty.

The rhombic dodecahedron is an all space filler. Its simplex defined by the following points.

O (0.0,0.0,0.0)

A (0.0,0.5,0.707..)

A' (0.0,0.577..,0.816..)

B (0.707..,0.0,0.707..)

C (0.0,0.0,0.707..)

C' (0.0,0.0,1.0)

0.577..=1/√3

0.707..=√2/2

0.816..=√(2/3)

STACK it to infinity! One Rhombic Dodecahedron has tetra volume 6. Six tetrahedra as per a *Synergetics* [3] accounting that even Euclid would agree with. The Rhombic Dodecahedron's 12 vertices are the centres of the voids of a close pack of spheres.

Trim Tab's claim of the 'closest' packing of spheres was inspirational for me but as I later learned Kepler had proved centuries before that there are an Infinitude of variant sphere packings, each with the same minimum density.

Permit me a speculation: one such packing must be behind the magic angle that produces super conductivity in layered graphene. If this is not Trim Tab's '*great circle railroad tracks of energy'*, or a control circuit for his '*Nuclear Computer*' [3]… I blather.

Description of 18 Rhombic Dodecahedra

In my latest animations only the paint moves. With space fixed and containing a stationary polyhedral domain, I record a *TIME-PAINT CONTINUUM.* One rotation of a texture map is all it takes, in 0.1 degree increments.

Other manipulations to the texture map are possible. This method permits seamless video loops.

In this animation I stacked 2 groups of 9 rhombic dodecahedra aligned to complimentary axes of symmetry. Then I rotated a texture map through 360 degrees. I used a public domain image:

Mandel Zoom 05 Tail Part.jpg

By Wolfgang Beyer using *Ultra Fractal 3, some rights reserved.*

Limits

Whereas 27 years ago a dihedral mirror assembly harnessed chaos at the speed of light to create a cohesive dynamic display, today my CAD database of dihedral patterns accomplishes more satisfying visuals but not in real time.

On my new system it takes 10 hours to capture 3600 frames. I script keyboard and mouse actions to implement my scene change and screen capture algorithm; coding of a sort. This animation method is not native to the CAD system I use.

The User's curse, the scourge of the *Eternal Carriage Return*, returns! Carpel diem.

Who am I kidding? Wetware limits all generative art. Hardware and software have limits too. Not knowing what those limits are adds excitement to the creation of pixels. Never knowing if what you asked of the computer would be art or blue screen. I am so glad that computer systems work more reliably than they used to.

My Simple Message

To this day wetware chooses! Wetware chooses, despite risk of carpel tunnel injury. Wetware chooses, from the available menu, how best to mitigate space-time and competing messages.

My semi-century of computer use intent on representing aspects of Synergetic Geometry has lead me along surprising paths. Some of them random, some a drunken meander looking for keys under the light post instead of where I lost them and some paths may have been 'generative'.

Maybe even beautiful to somebody's wetware.

References

1. Cosmos and History the Myth of the Eternal Return, Mircea Eliade Harper & Rowe, 1959.

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3. Synergetics, R.Buckminster Fuller, 1975, Macmillan, New York

Further Reading

1. Digitally Spelunking the Spline Mine, Curtis L Palmer, Bridges MathArt Conference Proceedings, 2005, pp 309-312.

2. Spelunking Adventure II: Combining Cyclons, Curtis L Palmer, Bridges MathArt Conference Proceedings, 2009, pp 335-336.

3. Pieces of Pi? Polyhedra, Orthoschemes and Dihedral Kaleidoscopes, Curtis L Palmer, Bridges MathArt Conference Proceedings, 2011, pp 625-628.

4. Spelunking Adventure III: Close-Pack and Space-Fill Octahedral Domains, Curtis L Palmer, Bridges MathArt Conference Proceedings, 2012, pp 525-526.

5. Retrograde Rotation Illusions in Turntable Animations of Concentric Icosahedra Domains, Curtis L Palmer, Bridges MathArt Conference Proceedings, 2013, pp 491-494.

6. Spelunking Adventure VI: An Equal Tempered Icosahedral Scale, Curtis L Palmer, Bridges MathArt Conference Proceedings, 2016, pp 557-560.