

Where is the math in art?

A roaming hackerspace art walk
organized by Aaron Fenyes & Romy Ilano

Sudo Room & Noisebridge @ SF^{MO}MA

August 1, 2024

These are some of the “Earthseed” verses from Octavia Butler’s *Parable* novels. All of the verses are collected at <https://g-dischange.org> (replace – with o).

All that you touch
You Change.

A gift of G-d
May sear unready fingers.

Intelligence is ongoing, individual adaptability.
Adaptations that an intelligent species may make
in a single generation, other species make over
many generations of selective breeding and
selective dying. Yet intelligence is demanding.
If it is misdirected by accident or by intent, it can
foster its own orgies of breeding and dying.

Prodigy is, at its essence,
adaptability and persistent,
positive obsession. Without
persistence, what remains is an
enthusiasm of the moment. Without
adaptability, what remains may
be channeled into destructive
fanaticism. Without positive
obsession, there is nothing at all.

We do not worship G-d.
We perceive and attend G-d.
We learn from G-d.
With forethought and work,
We shape G-d.
In the end, we yield to G-d.
We adapt and endure,
For we are Earthseed
And G-d is Change.

All that you Change
Changes you.

In order to rise
From its own ashes
A phoenix
First
Must
Burn.

We are all G-dseed, but no more or less
so than any other aspect of the universe.
G-dseed is all there is—all that
Changes. Earthseed is all that spreads
Earthlife to new earths. The universe is
G-dseed. Only we are Earthseed. And the
Destiny of Earthseed is to take root among
the stars.

A victim of G-d may,
Through learning and adaption,
Become a partner of G-d,
A victim of G-d may,
Through forethought and planning,
Become a shaper of G-d.
Or a victim of G-d may,
Through shortsightedness and fear,
Remain G-d’s victim,
G-d’s plaything,
G-d’s prey.

The Destiny of Earthseed
Is to take root among the stars.

G-d
Is Change.

All successful life is
Adaptable,
Opportunistic,
Tenacious,
Interconnected, and
Fecund.
Understand this.
Use it.
Shape G-d.

To get along with G-d,
Consider the consequences of your behavior.

All struggles
Are essentially
power struggles.
Who will rule,
Who will lead,
Who will define,
refine,
confine,
design,
Who will dominate.
All struggles
Are essentially power struggles,
And most are no more intellectual
than two rams
knocking their heads together.

Embrace diversity.
Unite—
Or be divided,
robbed,
ruled,
killed
By those who see you as prey.
Embrace diversity
Or be destroyed.

G-d is Power—
Infinite,
Irresistible,
Inexorable,
Indifferent.
And yet, G-d is Pliable—
Trickster,
Teacher,
Chaos,
Clay.
G-d exists to be shaped.
G-d is Change.

Belief
Initiates and guides action—
Or it does nothing.

Civilization is to groups what intelligence is
to individuals. It is a means of combining the
intelligence of many to achieve ongoing
group adaptation.

Any Change may bear seeds of benefit.
Seek them out.
Any Change may bear seeds of harm.
Beware.
G-d is infinitely malleable.
G-d is Change.

Once or twice
each week
A Gathering of Earthseed
is a good and necessary thing.
It vents emotion, then
quiets the mind.
It focuses attention,
strengthens purpose, and
unifies people.

Drowning people
Sometimes die
Fighting their rescuers

We are Earthseed
The life that perceives itself
Changing.

Civilization, like intelligence, may serve well,
serve adequately, or fail to serve its adaptive
function. When civilization fails to serve, it must
disintegrate unless it is acted upon by unifying
internal or external forces.

G-d is neither good nor evil,
neither loving
nor hating.
G-d is Power.
G-d is Change.
We must find the rest of what we need
within ourselves,
in one another,
in our Destiny.

Changes.
The galaxies move through space.
The stars ignite,
burn,
age,
cool,
Evolving.
G-d is Change.
G-d prevails.

Why is the universe?
To shape G-d.

Here we are—
Energy,
Mass,
Life,

When apparent stability disintegrates,
As it must—
G-d is Change—
People tend to give in
To fear and depression,
To need and greed.

G-d is neither good nor evil,
neither loving
nor hating.
G-d is Power.
G-d is Change.

As wind,
As water,
As fire,
As life,
G-d
Is both creative and destructive,
Demanding and yielding,
Sculptor and clay.
G-d is Infinite Potential:
G-d is Change.

Why is G-d?
To shape the universe.

Shaping Life,
Mind,
Shaping Mind,

When no influence is strong enough
To unify people
They divide.

Any Change may bear seeds of benefit.
Seek them out.
Any Change may bear seeds of harm.
Beware.
G-d is infinitely malleable.
G-d is Change.

A tree
Cannot grow
In its parents’ shadows.

G-d,
Shaping G-d.
Consider—
We are born
Not with purpose,
But with potential.

They struggle,
One against one,
Group against group,
For survival, position, power.
They remember old hates and generate new ones,
They create chaos and nurture it.
They kill and kill and kill,
Until they are exhausted and destroyed,
Until they are conquered by outside forces,
Or until one of them becomes
A leader.
Most will follow,
Or a tyrant
Most fear.

There is no end
To what a living world
Will demand of you.

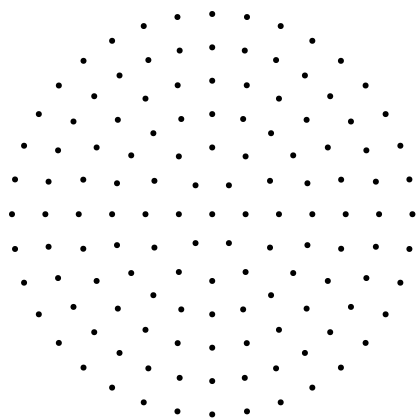
Your teachers
Are all around you.
All that you perceive,
All that you experience,
All that is given to you
or taken from you,
All that you love or hate,
need or fear
Will teach you—
If you will learn.

Kindness eases Change.

G-d is your first
and your last teacher.
G-d is your harshest teacher:
subtle,
demanding.
Learn or die.

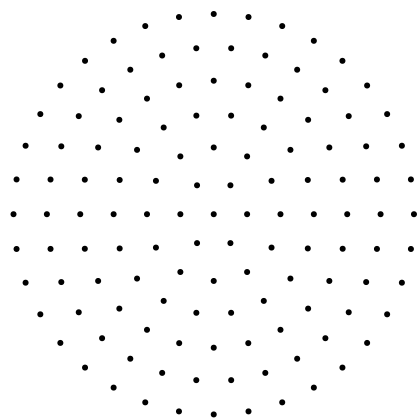
Earthseed
Cast on new ground
Must first perceive
That it knows nothing.

The Self must create
Its own reasons for being.
To shape G-d,
Shape Self.



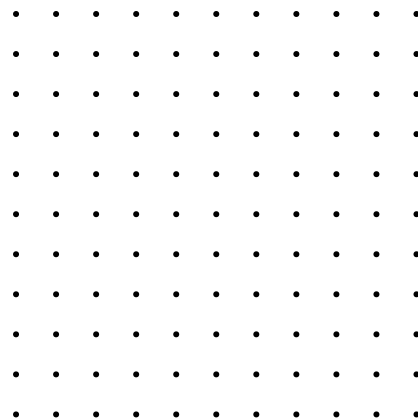
Braun T 4 and T 41 radios, by Dieter Rams (1959 and 1962).

Rings of 6, 12, 20, 24, 32, 36 holes. A matching catalogued sequence: “complement of rank transform of $\lfloor n/\sqrt{2} \rfloor$ ” (OEIS A187352).

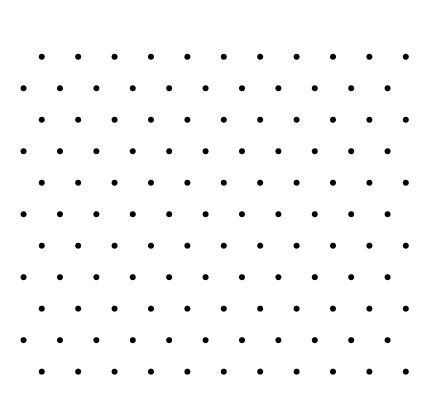


Minerva Pop record player, by Mario Bellini (1968).

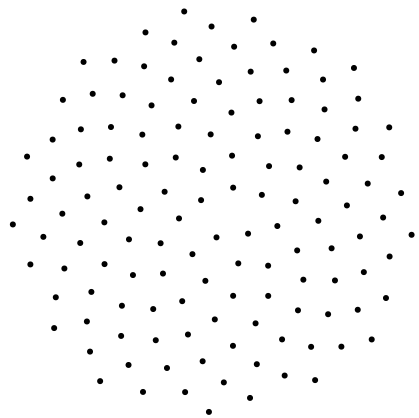
Rings of 6, 12, 18, 24, 30, 36 holes. Successive multiples of six.



Braun TP 1 transistor radio, by Dieter Rams (1959).

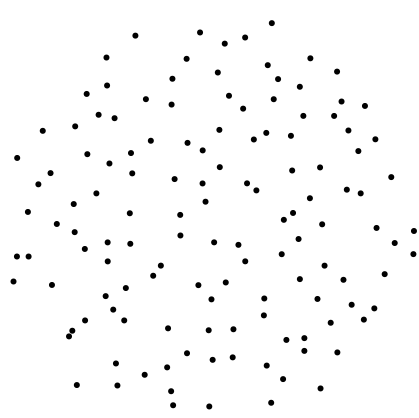


Braun L 810 speakers, by Dieter Rams (1969).



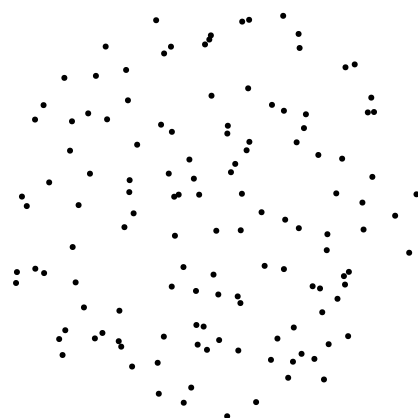
Golden Fermat spiral.

The Fibonacci256 LED display by Jason Coon (2024) is laid out in a larger version of this spiral, with an extra point added to fill in the empty space at the center.



The eigenvalues of a random complex matrix with normally distributed entries.

These eigenvalues act like mutually repelling particles in a bowl. That’s how they arrange themselves into a disk, mostly keeping each other at a distance.



Uniformly distributed random points in a disk.

These random points are independent of each other, so there’s nothing to stop them from getting close together.

Graphic design and print layout use a lot of mathematical tools. That was especially apparent in the era when all drawing was physical and all computation was human-powered, explored in the documentary *Graphic Means*.

Some mathematical design tools, old and new

Line and angle templates

- ▶ Straightedge
- ▶ T-square
- ▶ Triangle ruler
- ▶ Protractor

Curve templates

- ▶ Circle template
- ▶ French curve
Invented by German geometer and physicist Ludwig Burmester

Curve-drawing mechanisms

- ▶ Ellipsograph
 - ▶ Two tacks and a string
 - ▶ Trammel of Archimedes
- ▶ Hanging chain
The physical manifestation of a *catenary* curve
- ▶ Spirograph
- ▶ Pen plotter

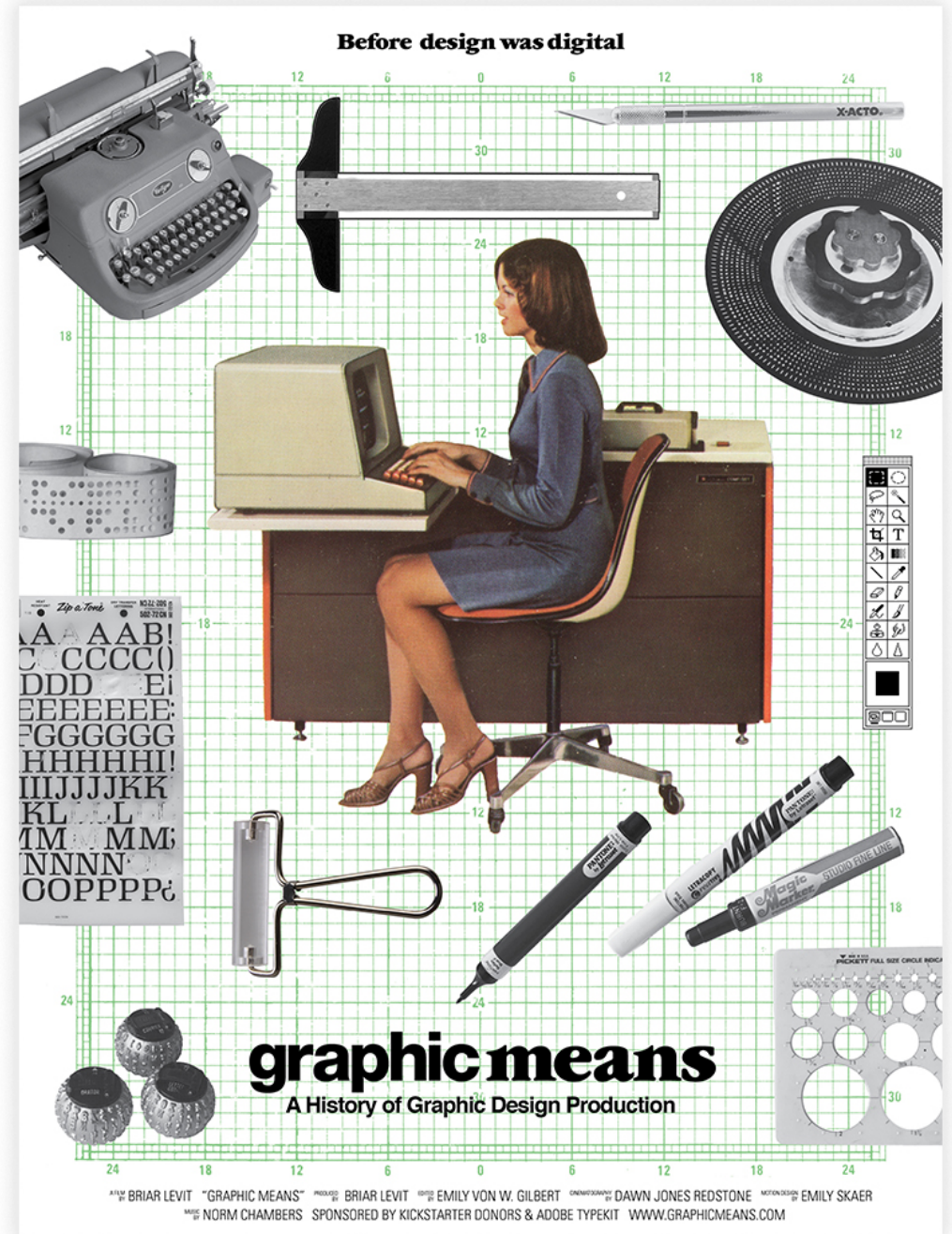
Splines

See Freya Holmér's film *The Continuity of Splines* for much more!

- ▶ Physical flat spline
- ▶ Bézier curve
- ▶ B-spline
"Basis spline"
- ▶ NURBS curve or surface
"Non-uniform rational basis spline"
- ▶ Spiro spline
Invented by Raph Levien, using ideas from the *calculus of variations*. See Levien's Ph.D. thesis, "From Spiral to Spline: Optimal Techniques in Interactive Curve Design."

Representing three-dimensionality

- ▶ Perspective projection
- ▶ Parallel (isometric) projection





"Melencolia I," by Albrecht Dürer. Engraving, 1514.

The grid in the upper right corner is a magic square: its rows, columns, and diagonals sum to 34.

"[A] time-honoured 'party game' that has attracted art historians and scientists for many years: guessing the nature and meaning of the enigmatic stone polyhedron. [...] A commonly accepted rule of the game is the assumption that the polyhedron is formed by starting with [...] a three-dimensional figure whose faces are six congruent rhombi (a cube is such a figure). Then, with the longest diagonal held vertically, congruent tetrahedra are cropped off the top and bottom." —Futamura, Frantz, and Cranell in "The cross ratio as a shape parameter for Dürer's solid"

<https://doi.org/10.1080/17513472.2014.974483>



"Anti-Dürer," by Anatoly Fomenko. India ink and pencil on paper, 1975.

"Since Dürer's time, so much has changed in our understanding of the universe, and our knowledge of mathematics has so vastly grown. Yet, basic truths remain the same. Many mathematical ideas wend their way through this picture. For instance, hanging on the wall in the upper right-hand corner is the number e , the first 121 digits unwinding counterclockwise from the center in a spiral square. Inscribed in the clapper of the hanging bell is a representation of a separatrix diagram of a critical point of index one for a smooth function defined in three-dimensional space. Even the clouds in the background were serendipitously inspired by mathematical forms." —Anatoly Fomenko in *Mathematical Impressions*, p. 124

<https://archive.org/details/mathematicalimpr0000fome>

Zarina

Many of Zarina’s pieces invoke references to counting in religious traditions (“Tasbih,” “The Ten Thousand Things”), evoke a feeling of counting endlessly (“The Ten Thousand Things,” “Beyond the Stars”), include astronomical imagery (“Beyond the Stars,” “Moon”), or do some combination of those. You can find some photos of her work in:

“Remembering Zarina, 1937–2020,” by Sean Anderson, Christophe Cherix, Rattanamol Singh Johal, Glenn D. Lowry, and Sarah Suzuki.
<https://www.moma.org/magazine/articles/307>

“She did her graduation in mathematics. Her interest in the same and architecture is portrayed in her use of geometry and the accuracy of structures in all her works. And her poignant minimalism is what makes her career exemplary. While growing up, it was the magnificent yet subtle architecture of Fatehpur Sikri that inspired her to learn about minimalism. The architecture of mediaeval India served as the root for her passion and love for drawing straight lines.

“In modern scholarship, Zarina’s art has been interpreted in the light of transnationalism and cosmopolitanism to a greater extent. However, it can be argued that the core of her art has always been about the life-changing event of displacement for millions in India, which we so casually term the ‘Partition’.

“While studying at Aligarh Muslim University, Zarina met Indian diplomat Saad Hashmi, whom she eventually married. In her early years of marriage, she travelled widely and was introduced to woodblock printing in Bangkok. Most of her works are woodcuts or etchings printed on handmade paper. Since she was a mathematician-turned-artist, the geometric precision in her artwork is clearly apparent. Besides architectural plans for houses, her work also involved cartography. She had a deep interest in geography as well as in how cities were built. Words, too, were a strong language that she implemented in her moving art.

“Among all her many astounding works, her ‘Dividing Line’ (2001) stands out because of its minimal yet formidable nature, myriad interpretations and some specific connotations. At first glance, it appears as a mere black line inscribed on a piece of paper. However, by observing carefully, one will eventually notice that it is the tension-fraught border of India and Pakistan, or rather the ‘Radcliffe Line’, the introduction of which changed the trajectory of her life and millions of others entirely.”

—Sharmistha Dasgupta in “Remembering Zarina Hashmi and the idea of home”

Conversation-starters

Prayer beads are used in religions around the world, and possibly have been for millennia. Can counting be a spiritual experience?

Cartography, like the warplane in Anselm Kiefer’s “Melancholia,” is a tool made possible by math—a tool that can be used to carry out mass destruction.

Olafur Eliasson

Optics and geometry appear throughout Olafur Eliasson’s work, and Eliasson speaks explicitly about the mathematical parts of his design process. You can find photos and descriptions of many pieces in his online portfolio:

<https://olafureliasson.net>

“I’m fascinated by geometry and partial to all things circular and spherical. They have this powerful, almost cosmic dimension. Most of my earlier spheres are, in fact, complex polyhedra. To develop these forms, I collaborated for many years with the Icelandic geometer and architect Einar Thorsteinn.” —Olafur Eliasson in an interview with Nina Azzarello for *Designboom*

“‘Orbital close encounter’ evolved from a series of sculptures that Eliasson produced in 2019, titled ‘Human time is movement.’ The sculptures, spiralling spheres formed by pipes curving back in around themselves, are variations on a mathematical figure known as the Clelia curve. Named after the countess Clelia Grillo Borromeo by the early-eighteenth-century Italian mathematician Guido Grandi, the curve traces the progress of a point as it moves simultaneously along a sphere’s meridian and rotates at a constant speed around its axis. The resulting curve corresponds to the way one peels an orange or winds up a ball of wool. The strikingly different forms seen in Eliasson’s works, on the other hand, are produced by adjusting the speeds of rotation and by contracting the curve in towards the centre as the point travels.” —From Olafur Eliasson’s online portfolio

“‘Your sound galaxy’ suspends a group of twenty-seven polyhedrons [...] organisable into nine ‘families’ of three related forms. In these families, two of the three polyhedrons are designated as duals of one another, meaning that the number of vertices on the one polyhedron is equal to the number of faces on the other. Constructing two duals within each other creates the third polyhedron of the family, called a compound. The work’s title gestures to a recurring worldview in Western metaphysics [...] which describes the motion of celestial bodies in terms of a natural harmony [...]” —From Olafur Eliasson’s online portfolio

This description of “The drewdrop agora” evokes the idea of *sphere packing*:

“Packed tightly on a steel support, forty-eight glass spheres of various sizes seem, from a distance, to burst forth from the wall with the apparent disorganisation of organic phenomena – like a cluster of water droplets or a clutch of eggs.” —From Olafur Eliasson’s online portfolio

Conversation-starters

“One-way colour tunnel” is a long, repetitive passage that feels very different when you turn around. The same can be said about the long arm of a Gothic cathedral.