Geometric design by principles and random sampling

Luis Alvarez and Jean-Michel Morel
Cueva de las manos, Argentina, 9,000 years ago
Formalization of the Prehistoric Composition

• Choice of basic shapes used to create the composition.
We use Delauny triangulation to manage shapes.
New shape generation using geometric transform and composition rules

Random Euclidean transformation with exclusion principle
Colour assignment

Color Palette

Simulation
Random Euclidean transformation with exclusion principle changing the shape size
Euclidean transformation with exclusion principle and a one given shape orientation
Euclidean transformation with exclusion principle and two shape orientations
Euclidean transformation with exclusion principle and one vanishing point
Random Euclidean transformation with occlusion principle
Random Euclidean transformation with occlusion principle and transparency.
Tessellation: Image domain partition using random Euclidean transformation with occlusion principle
Tessellation rendering: Different colors are associated to each connected component of the tessellation.
Tessellation rendering with a large number of shapes.
Tessellation rendering with a large number of shapes.
Tessellation rendering with a large number of shapes.
Abstract geometric designs created by leading painters

Malevich

Malevich

Van Doesburg

Buchheister

Kandisky

Mondrian

Mondrian

Arp
Piet Mondrian (1921) Composition with Large Red Plane, Yellow, Black, Gray and Blue

Mondrian 1921  van Doesburg  Seuphor, 1929  Helion 1930

Sonia Delaunay, 1931  Leger 1924  Torres 1929  Domela 1926

Design in the style of Mondrian

What is the Law of Chance?

Arp writes: “the law of chance can only be experienced through complete devotion to the unconscious”. “Using this process ‘according to the law of chance’, isn’t per se, using chance.” “I further developed the collage by arranging the pieces automatically, without will.” “We do not want to copy nature. We do not want to reproduce, we want to produce”.

“I wanted to find another order, another value of man in nature. I wanted to create new appearances, extract of man new forms”
Jean Arp (1917)
Collage with Squares Arranged According to the Laws of Chance
Jean Arp (1917)
Collage with Squares Arranged According to the Laws of Chance

Original

Simulation 1

Simulation 2

Simulation 3

Simulation 4

Simulation 5

Simulation 6

Simulation 7
Nonlinear deformation

Jean Arp 1917. Collage with Squares Arranged According to the Laws of Chance

Wassily Kandinsky 1913. Color Study: Squares with Concentric Circles
Nonlinear deformation transforms

Let \((x, y) \in \mathbb{R}^2\) and \((x_c, y_c)\) the deformation center. We define the following transformation

\[
\varphi = \text{atan2}(y - y_c, x - x_c)
\]

\[
\varphi' = \varphi_0 + k_0 \beta_0(\varphi)
\]

\[
\begin{pmatrix}
  x_c \\
y_c
\end{pmatrix}
+ \begin{pmatrix}
  \cos(\varphi') & -\sin(\varphi') \\
  \sin(\varphi') & \cos(\varphi')
\end{pmatrix}
\begin{pmatrix}
  1 & 0 \\
  0 & 1 - k_1 \beta_1(\varphi - \varphi_1)
\end{pmatrix}
\begin{pmatrix}
  \cos(\varphi') & \sin(\varphi') \\
  -\sin(\varphi') & \cos(\varphi')
\end{pmatrix}
\begin{pmatrix}
  x - x_c \\
y - y_c
\end{pmatrix}
\]

where \(k_0, k_1 \geq 0, \varphi_0, \varphi_1 \in [0, 2\pi], \beta_0, \beta_1 \in W^{1,\infty}(\mathbb{R})\) are \(2\pi\) periodic functions.
Wassily Kandinsky 1913 . Color Study: Squares with Concentric Circles

Original

Simulation 1

Simulation 2

Simulation 3
Wassily Kandinsky 1913. Color Study: Squares with Concentric Circles

Original

Simulation 1

Simulation 2

Simulation 3
Wassily Kandinsky 1937. Thirty
Henri Matisse (1952) The Parakeet and the Mermaid.
Collaboration with the professional painter José Antonio García
Symmetry and Periodicity

Rossete (Egypt)  Mandala (Tibet)  Persian carpet  Baschet (Hermes)

Van der Leck  Daphnis  Downing  Boto
Weak Symmetry versus Strong Symmetry

Catherine Baschet (Hermes Silk Twill Scarf)

Simulation of 45º strong symmetry
Designs inspired in Persian Carpets

Simulation 1

Simulation 2
Designs inspired in Persian Carpets

Simulation 1

Simulation 2
Designs inspired in Persian Carpets and Kandisky circles

Simulation 1

Simulation 2
Shape connectivity

Gustav Klimt, 1909, The Tree of Life

Simulation 1

Simulation 2

Simulation 3
Shape connectivity

Simulation 1

Simulation 2

Simulation 3

Simulation 4
Tesselations

Freundlich  Klee  Robert Delauny  Torres García

Ackerman  Asis  Gray  Gray
Tessellations

Simulation 1

Simulation 2
A Multilayer Approach to Geometric design

Mondrian
Kandisky
Matisse

Alechinsky
Goodnough
Barbeau
Pollock
A Multilayer Approach to Geometric design
!! THANK YOU !!

http://www.ctim.es/ImageSynthesis/