BRIDGES COIMBRA

Mathematics, Music, Art, Architecture, Culture

Art Exhibition Catalog

• U  C •

2011

Celebrating the 14th Annual Bridges Conference in the University of Coimbra
Established 1290 – The First University in Portugal

Art Exhibition Catalog 2010

Robert Fathauer and Nathan Selikoff, Editors
Tessellations Publishing

BRIDGES COIMBRA

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PREFACE

In 2011, the Bridges Conference is being held at the University of Coimbra, Portugal, July 27–31. The University of Coimbra was established in 1290 as the first university in Portugal, and the first Portuguese language university in the world!

Coimbra has a rich history. It contains important archeological remains of structures dating from the time when it was a Roman town called Aeminium, such as its well preserved aqueduct and cryptoporticus, as well as from the period when it served as the capital of Portugal (from 1139 to about 1260). In the Late Middle Ages, declining as the political centre of the Kingdom of Portugal, Coimbra began to evolve into a major cultural centre with the foundation of the University of Coimbra in 1290. Today the university with its long history and monumental buildings attracts many visitors from around the world and is also an important tourist attraction.

After the much larger metropolitan areas of Lisbon and Porto, Coimbra is the most important urban focal point of the central part of the country. It is situated on the Rio Mondego, the longest river located exclusively in Portugal. The river flowing through the city provides a scenic setting for the town centre that invites everybody for walks along its river banks and across its four bridges. It is a lovely setting for our Bridges conference!

Since last year the conference has grown again and is setting new records. We received more paper and workshop submissions than ever before, presenting intriguing ideas in mathematics, in the arts, and in several other cultural domains that can benefit from a description or analysis using mathematical notations and techniques. This year the keynote paper is coauthored by Fields medalist William P. Thurston. Another plenary paper will be presented by Paulus Gerdes, the president of ISGEm, the International Study Group on Ethnomathematics.

The formal talks are complemented by a wide variety of hands-on workshops, a juried art exhibition and several evening programs devoted to music, theater performances, and movies with an art-math theme, and special day programs devoted to poetry and family art-math activities. There is also a day-long excursion to various museums and cultural sites.

The workshops provide hands-on extensions of many lectures, where a smaller group of participants can immerse themselves more fully in a specific topic—often focused on the teaching of some mathematical skills to students of all ages. As in many previous years, Mara Alagic and Paul Gailiunas have taken charge of this important part of the conference. But this year we had more workshop submissions than ever, and there will be a complete track paralleling all the sessions of regular and short papers.

The local organizers also planned a Portuguese Math/Art Day, which features invited talks by Manuel Arala Chaves (Associação Atractor—www.atractor.pt), Paulus Gerdes (Maputo, Mozambique) and João Paulo Xavier (University of Porto), complemented by workshops on the symmetry of plane patterns, on Roman architecture in Portugal, and on Lunda Art, inspired by Sona Geometry from Angola. A special 3D projection show with some of the nice stereoscopic materials produced by Associação Atractor has been produced for this occasion.

An exhibition of mathematical art has been an annual feature of Bridges since 2001, and it has grown steadily over the years under the dedicated leadership of Robert Fathauer. This year, work was submitted by more than 70 artists from 20 countries. Diverse artistic media are represented, including wood, metal, and stone sculpture, beadwork, and fabric, in addition to a variety of two-dimensional media. Mathematical ideas at play in the art exhibition encompass tilings, fractals, polyhedra, hyperbolic geometry, anamorphosis, knots, topology, and magic squares. Anne Burns, Ana Isabel Cardoso, and Nat Friedman joined Robert Fathauer on the jury. The exhibition website was created by Nathan Selikoff, and Nathan and Robert also edited the catalog for the exhibition.

The Bridges conference always had a Music Night. This year Dmitri Tymoczko is again organizing this popular event. Coimbra's professional orchestra, the Orquestra Clássica do Centro, has graciously agreed to play a concert featuring new and old works, including a mathematically inspired composition by Giovanni Albini, and new works by Dmitri Tymoczko and Vi Hart.

Over the years we have experimented with many different formats for Theater Night. This year the event is orchestrated by Steve Abbott; it is focused on a single dramatic piece: The Physicists, by Friedrich Durrenmatt, performed in the form of a staged reading by conference participants. The play takes place in a home for the mentally ill, which counts Isaac Newton and Albert Einstein among its patients. Although the moral responsibility of scientists is the dominant theme of this tragic comedy, topology also plays an interesting role, as the central character is another scientist, named Mobius, who is taking refuge in the sanatorium and negotiates the politics of the madhouse.

Last year we inaugurated a new conference event: The Bridges Math Art Short Movie Festival. A rapidly growing number of artists and educators are using movies, videos, and animations for applications spanning education, industry, and the arts. Since one of the objectives of the Bridges organization is to introduce participants to innovative and integrative techniques, we will continue the venue launched last year, and we will screen many short movies with an art-math topic.

The importance of Family Day is growing yet further this year. Kristóf Fenyvesi, our coordinator of community events, has been working together with Ana Maria de Almeida and Maria Emília Bigotte to create a fun-filled day for families, offering onsite immersion into the world of mathematics and arts. Conference participants, including educators, workshop holders, and animators, as well as various local artists, have collaborated to prepare a variety of interesting community activities, ranging from presentations and interactive demonstrations to games, workshops, and a mathematical flea market.

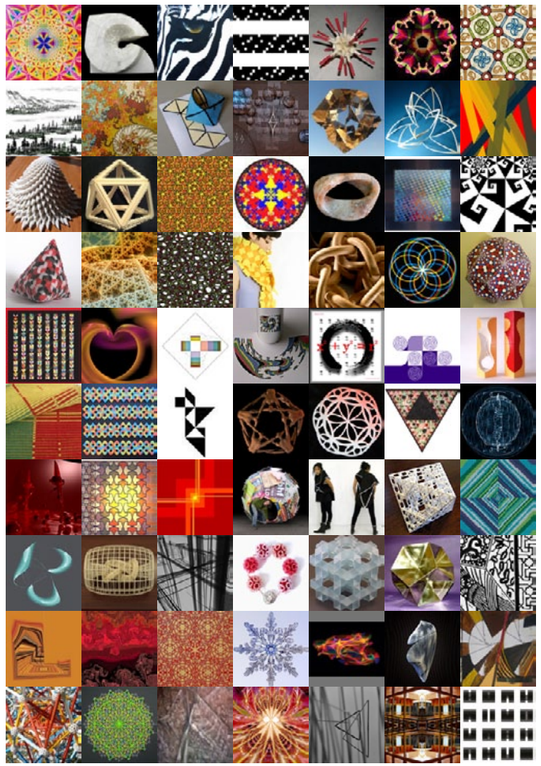
Poetry Day is a new addition this year to the Bridges Conference. This event, coordinated by Sarah Glaz, University of Connecticut mathematician and poet, is a reading of poems with strong links to mathematics. The invited readers are a diverse group of poets whose specialties include mathematics, philosophy, history, teaching, translating and conducting scholarly work on the connections between mathematics and poetry. Reading their own poems are Emily Grosholz, JoAnne Growney, Amy Uyematsu and Sarah Glaz. Saeed Ghahramani will read modern Iranian poems in translation. Coimbra University mathematician and translator, Francisco Craveiro, will be joined by the other poets for a bilingual reading of mathematical poems he translated into Portuguese. Francisco will read the Portuguese translations, while the other poets will read the English originals. The event will end with an "open microphone" period in which Bridges participants can share their own mathematical poems with the audience.

Such a rich and varied event cannot be put together by just a few official chair persons; it takes the full energy of many dedicated individuals who have been laboring for several months and in a few instances for a couple of years to put this year's conference together. In addition to the organizers of the many events mentioned above that make up the wonderful mosaic that forms a Bridges conference, we would also like to express our special thanks to our team in Coimbra: Penousal Machado in the Department of Computer Science, Ana Almeida in the Department of Mathematics, and Amílcar Cardoso, the President of the Centre for Informatics and Systems at the University of Coimbra, Portugal, as well as the many local organizations and individuals who have helped to make this conference a reality, in particular:

- University of Coimbra, particularly to João Gabriel Silva, the Rector and José António Bandeirinha, former Culture Pro-Rector;
- City of Coimbra, particularly to Maria José Azevedo, Vice-Mayor;
- Machado de Castro Museum and its Director, Ana Alcoforado;
- Science Museum, particularly Paulo Gama Mota, Director, and Carlota Simões, Vice-Director;
- Turismo de Coimbra, particularly to Luís Alcoforado, the President;
- Instituto Superior de Engenharia de Coimbra;
- Math Department of the University of Coimbra;
- Centre for Mathematics of the University of Coimbra;
- Centre for Informatics and Systems of the University of Coimbra;
- Orquestra Clássica do Centro, particularly Artur Pinho, Conductor, and all his team;
- Grupo de Etnografia e Folclore da Academia de Coimbra (GEFAC);
- Design Atelier FBA., particularly André Ferrão.

Last, but not least, we would like to thank all the Bridges conference attendees, who often come from rather far-away places. It is really your active participation and enthusiasm that makes this conference such an exciting event.

The Bridges Organization Board of Directors
http://www.BridgesMathArt.org



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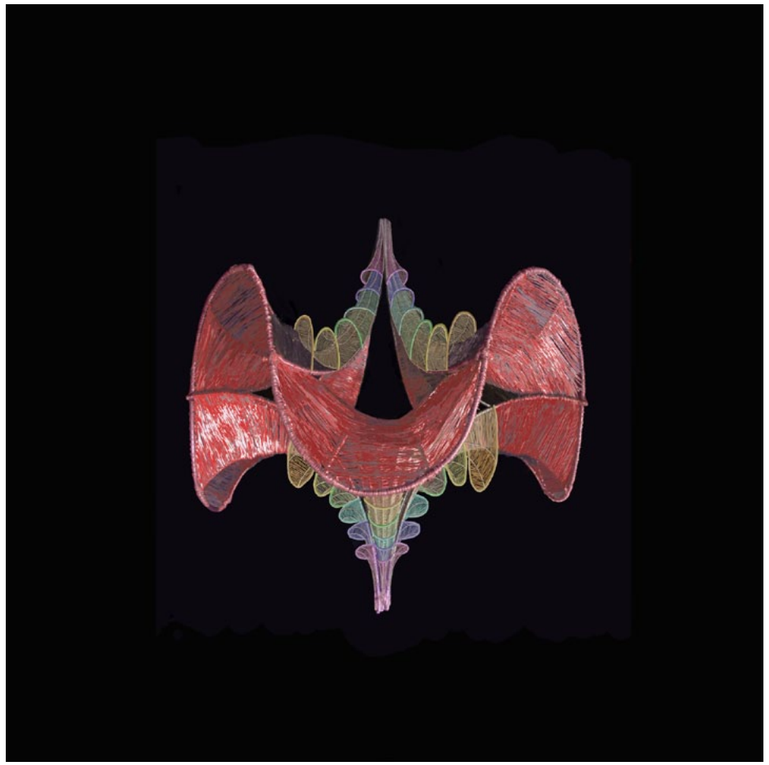
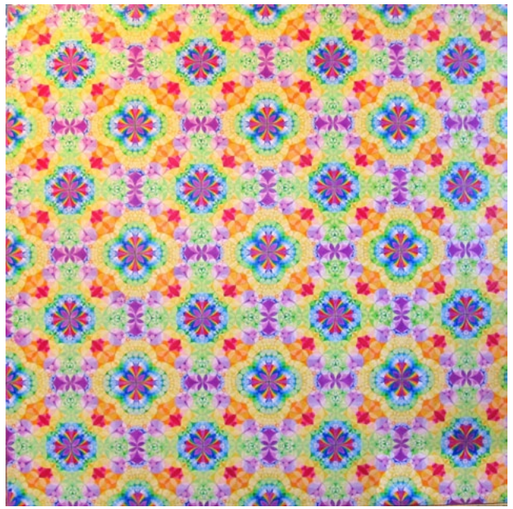


Flying Rainbow Lasagne
18"x18"x18"
Steel wire

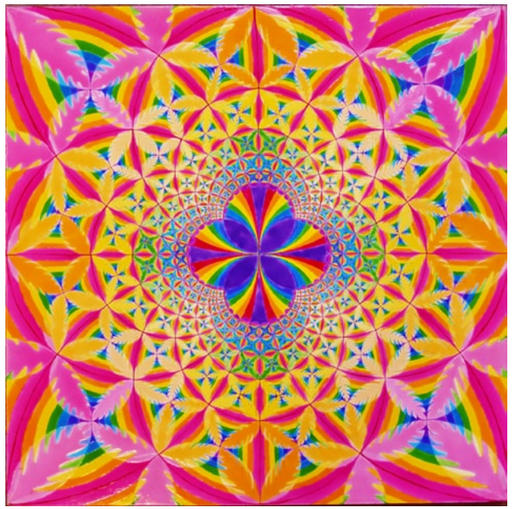
It is important to note that none of my artwork is computer generated. The basic drawings are all done by hand using simple tools such as a ruler, compass, and circle templates. It can take from six weeks to several months to understand and decipher the concepts behind the drawing, a process which would ordinarily be performed by a computer. I do not use a calculator in order to create these paintings, I use my mind to do the math. The value of this process is that, as the painting is completed, I embody these patterns and concepts and carry them within myself.

These paintings are more than just decorative colors and patterns. There is a mathematical subject matter, as each painting is based upon an internally-consistent set of rules and stands as a type of "visual equation" or "visual math problem." The paintings also refer to physics, and the rules which describe and govern the behavior of light waves.

Flying Rainbow Lasagne • This is a sculpture of a Flying Rainbow Lasagne (FRL). The FRL is the end result of applying a set of rules to the way that energy is allowed to move and behave. This shape has as it's basis the basic shape of a sphere that is morphed into four vortexes and finally, with the addition of a new dimension, forms the FRL shape. Like a Mobius Strip, The FRL is an "impossible" shape in that it only has one side: the 'inside' of one half-cone becomes the 'outside' of the next half-cone. (with "inside" being defined as a surface facing the interior of the FRL, and "outside" as a surface facing the floor or ceiling of the room) However, despite its' seeming impossibility, The FRL does not break any of the previously-established rules which govern the movement of energy in the universe and as a result is allowed to exist..



Energy
Original painting 48"x48", printed as 20"x24" for show
Acrylic paint on wood



Many Worlds
24" x 24"
Acrylic paint on wood

Energy • This painting extends a theme I have been exploring for several years based on the Mobius Transformation. Here, the pattern is taken to the extreme!

Many Worlds • Created as a design element of a larger painting, this image is partially inspired by the Mobius Transformation and also by the physics of lightwaves. As in my other paintings, each color corresponds to a particular size and the color proportions related to each color remain consistent. The painting shows a matrix formed by an interlinking network of nested vortexes, with each vortex maintaining internally-consistent color proportions.

JACQUES BECK

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Les Autres et Moi or Les Autres Emois (The Others and Me or The Alternate Emotions)
200 X 170 X 130 mm
white Carrara marble

A stone sculptor for more than twenty years after a long intro via wood cutting, I entered Bridges math-art last year introducing my concept of multisculpture, which shows common ground with Nat Friedman's hyperseeing. Emphasizing geometry and rational mechanics content, I could present and manipulate in the Art Exhibition a typical multisculpture shown in the catalogue as a matrix image (4 view directions for its 5 positions). This year, with another multisculpture and two classic sculptures, I illustrate my talk on the phenomenological aspects of traditional manual stone carving using its basic tools, point chisel and mallet. This personal account of its inherent complexity defines some of the minimal basics required for complete mathematical modelling that could one day bridge to fully automated end-to-end stone carving capabilities including the subjectivity of the artistic aspect, up to an eventual result indistinguishable from man-made art.

Les Autres et Moi or Les Autres Emois (The Others and Me or The Alternate Emotions) • This work belongs to the small series of multisculptures that were included in the Bridges Pécs 2010 paper. I like to present it here, because its genesis appears in the YouTube movie referenced in the Coimbra 2011 paper, and its shape has been recently reproduced in bronze, a piece that will also be shown in company of the original in the exhibit, yet off-catalogue. There are six positions, each one viewable from around as usual. Its shape reveals several circular lines and conical surfaces, spirals and helicoids, radii materialized by chisel strokes symbolizing perhaps 'the others around me', leaving a pathway to freedom. This metaphor can of course be changed with the positions, potentially creating other emotions. The point chisel strokes in the central cone have been modified in the bronze copy, and became more regular dips.

La Clé de Voûte (Keystone)
355 X 170 X 110 mm
white Carrara marble

La Clé de Voûte (Keystone) • Anthropomorphic sculpture shown here mainly in relationship to the paper as it has been carved only with the point chisel. Symbolically, it could represent the humble stone cutter shaped very synthetically yet with a rough coat and who is completing his magnificent arch work with the essential shiny pinnacle piece, that he brings to the building yard. Or, could this be the mathematical abstraction that buttresses a whole mathematical theory ?

Ode à la Paix (Ode to Peace)
290 X 220 X 200 mm
Belgian blue stone ('petit granit')

Ode à la Paix (Ode to Peace) • Work heavily carved towards lightness and presenting again very smoothed surfaces versus rough point chisel work, the substance of the presentation. It could symbolically represent a monumental fake dead-end open to the sky, so inviting to fly away with the Peace Dove. Or mimicking in a mathematical setting the very instant when the solution suddenly appears and gives soaring rise to instant peace to the mind.

FRANÇOISE BECK-PIETERHONS

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An Eye into Zebra Geometry
300 X 300 mm
Acrylic paint on canvas

Free-lance writer and Italianist, I express in animal painting my immense love and respect for our so-called 'inferior' friends. In a math-art community, why not try to capture participants' interest to aspects of animality close to mathematics, through the emotional appeal of the painting medium ?

An Eye into Zebra Geometry • Animal skins come in a huge variety of patterns, some with high geometrical content. The regular, rhythmical black and white alternation of the Zebra skin stripes keeps provoking a special visual fascination, that naturally extends to the arts. Even a browse through Bridges math-art catalogues reveals many geometrical patterns reminding one of animal skins. A striking example admired last year during a visit to the Pécs Vasarely Museum was that emblematic work with his entangled 'Zebras'. It is not widely known that these various patterns have been investigated for a very long time, and that in the preceding century quite an extensive number of scientific studies have been conducted, underpinned by complex mathematics describing chemical and biological realities that trace back to the evolution of embryos as the very genesis of strange regular skin patterns. Who would believe Alan Turing et al. had a considerable influence in this domain also? (After detail photo F. Rumpenhorst.)

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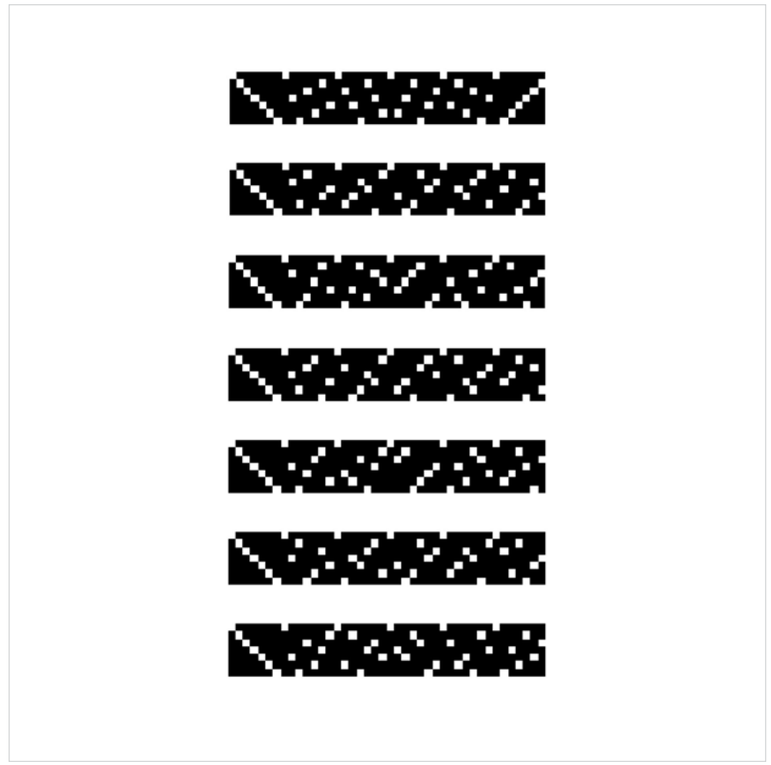

Random in 7-multiverse
12 x 18 inches
Digital print on canvas

One of the main goals of both science and art is to reveal fundamental principles governing space and time. This task can sometimes be facilitated by juxtaposing structure and randomness, intention and accident. Art that explores these relationships in a deep way does not function merely as a pleasing illustration of a mathematical principle, but forms an independent mode of an intellectual interrogation.

Random in 7-multiverse • Ideal quilts are Zak space representations of families of ideal sequences. Ideal sequences are sequences with certain special group-theoretical properties. In particular, ideal sequences satisfy the Sarwate bound, having both zero out-of-phase autocorrelation and minimum cross-correlation sidelobes. In effect, ideal sequences can be viewed as the quintessential random sequences, or, in the Duchamp language, standard stoppages. For sequence length equal to 7^2 there are exactly 7 sets of ideal sequences. These sequence sets are associated with certain special permutation groups. For further details, see the 2008 Springer book, "Ideal Sequence Design in Time-Frequency Space" by An, Brodzik and Tolimieri, or the forthcoming "Ideal Quilts" by Brodzik.

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Geodesics 2
15 cm x 40 cm x 30 cm
origami, paper, no glue

I graduated from Jagiellonian University in Krakow, Poland in 1983 in pure mathematics. I am a math teacher with more than 20 years experience.

I started my interest in origami in 1995. My mathematical background pushed me towards geometric models. A mathematical structure of origami model and folding process as well as relation of origami to mathematics have been in the center of my interest from that time. I am also interested in educational applications of origami. I had lectures and workshop on education and theoretical aspects of origami at KOTE, Poland and Didaktik des Papierfalten in Freiburg, Germany, and OSME (Origami, Science, .Mathematics and Education), USA and Singapure

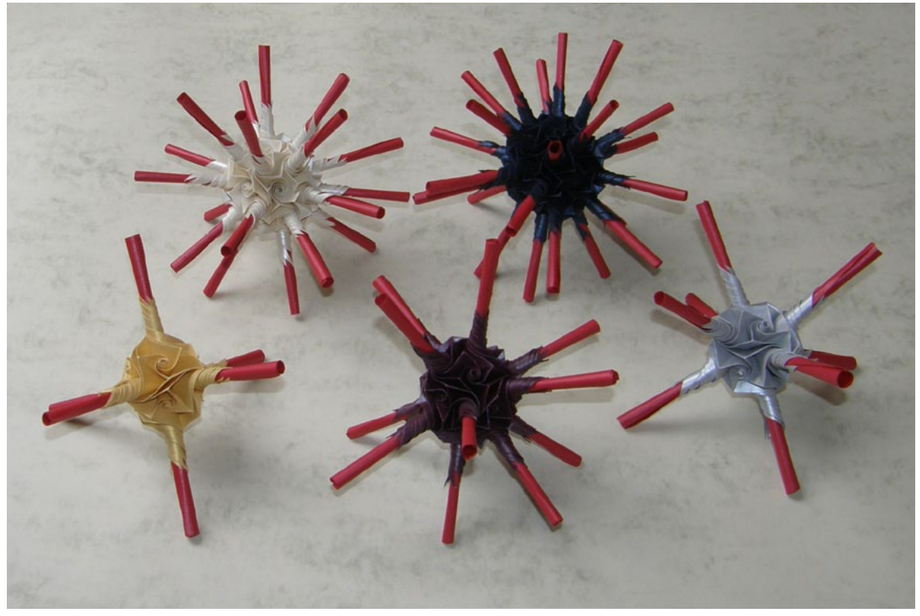
I am an author of five origami books and several booklets.
I participated in the large international origami exhibition "Masters of Origami" in Salzburg 2005 and Hamburg 2007.

Geodesics 2 • I played with different shapes of paper generated by a graph of a polynomial function. Region bounded by a polynomial graph is a starting shape of a paper sheets folded in a model. These three models are exactly the same except shape of paper used.

Duality • My origami models base on regular polyhedra structure. These two models are exactly the same, except that they are based on two dual polyhera, dodecahedron and icosahedron.

Spiders • This set of models is based on different regular polyhedra structures. "Legs" growing out of the central polyhedron resulted in the name of such models. From mathematical point of view these model illustrate groups of symmetry in the space.

Duality
13 cm x 30 cm x 30 cm
origami, paper, no glue



Spiders
20 cm x 45 cm x 45 cm
origami, paper, no glue

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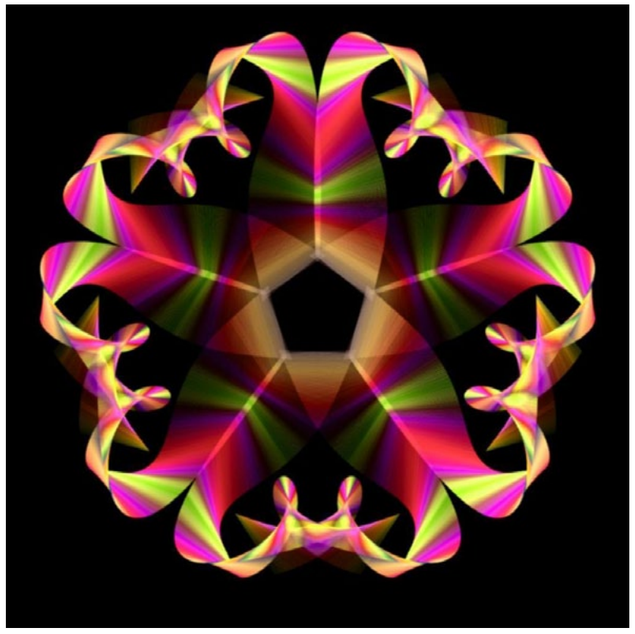


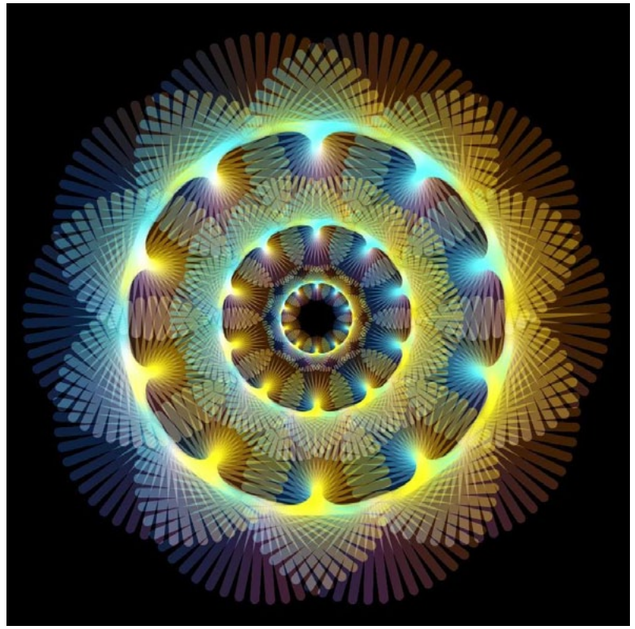
Complex Flow I
12" X 12"
Digital print

I began my studies as an art major and later became fascinated with mathematics. Computer programming allowed me to combine my two passions and to explore the visual beauty of mathematics.

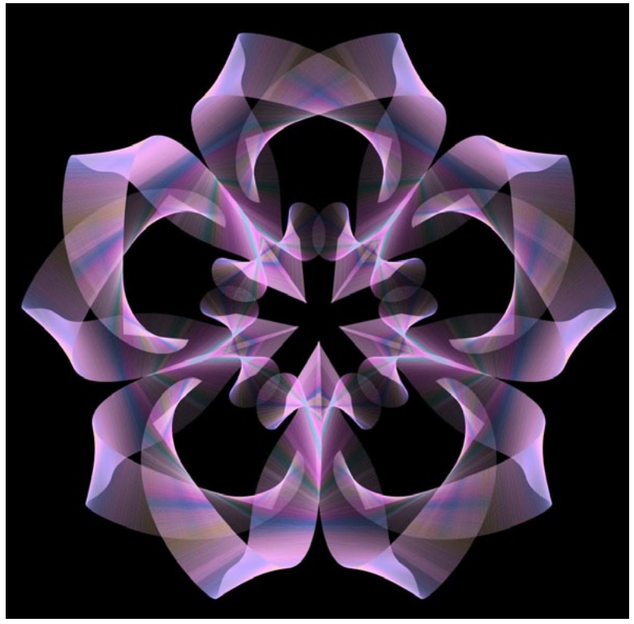
Complex Flow I • Vectors whose length and direction are determined by a complex analytic function and whose color is a function of the slope of the vector are plotted along a path y = f(x) and then reflected and rotated.

Complex Flow II • This flow diagram was Inspired by the vector field of the complex-valued function f(z)= z^11 along three circles centered at the origin .

Complex Flow III • This flow diagram was Inspired by the vector field of the complex-valued function f(z)= z^11 along three circles centered at the origin.



Complex Flow II
12" x 12"
Digital print



Complex Flow III
12" x 12"
Digital print

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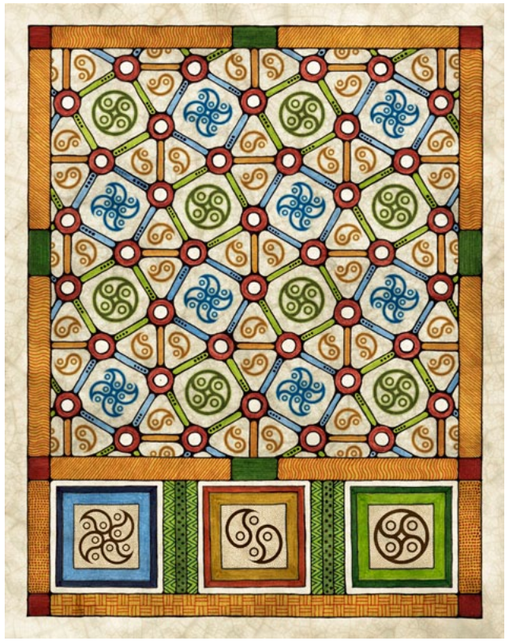

442, Variation I
24" x 20"
Archival inkjet print

442, Variation II
24" x 20"
Archival inkjet print

My work is motivated by a fascination with the occurrence of mathematical and scientific imagery in traditional art forms, and the frequently mystical or cosmological significance that is often attributed to such imagery. Mathematical themes both subtle and overt appear in a broad range of traditional art, from Medieval illuminated manuscripts to Buddhist mandalas, intricate tilings in Islamic architecture to restrained temple geometry paintings in Japan, complex patterns in African textiles to geometric ornament in archaic Greek ceramics. Often this imagery is deeply connected with how these cultures interpret and relate to the cosmos, in much the same way that modern scientific diagrams express the scientific worldview. I am especially interested in symmetry as a mechanism for finding order in the universe, from its intuitive appearance in ancient cosmological diagrams to its important role in modern theoretical physics, and my recent works explore various forms of symmetry.

442, Variation I • This work is part of a series of visual meditations on the symmetry groups of the two-dimensional Euclidean plane. This print focuses on the symmetry group p4 (orbifold signature 442) and its presentation by a particular set of three generators (generators {a,b,c}, with the relations aaaa = bbbb = cc = abc = 1). In the main section of the image, a network of connected dots forms a stylized Cayley diagram for this presentation of p4, while the small motifs at the bottom describe the local features of the orbifold for the symmetry group (in this case, one 2-fold and two 4-fold gyration or "cone" points). The image is constructed from multiple hand-drawn elements and natural textures which are scanned and digitally manipulated to form a composite image and subsequently output as an archival digital print.

442, Variation II • This work uses a set of two generators (generators {a,b} with relations aaaa = bb = abababab = 1).

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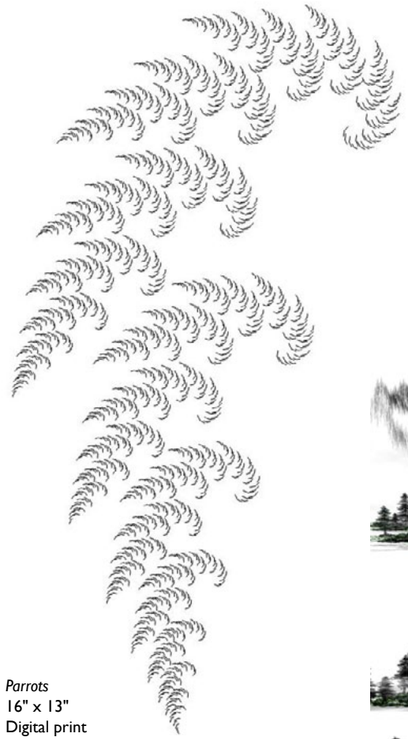
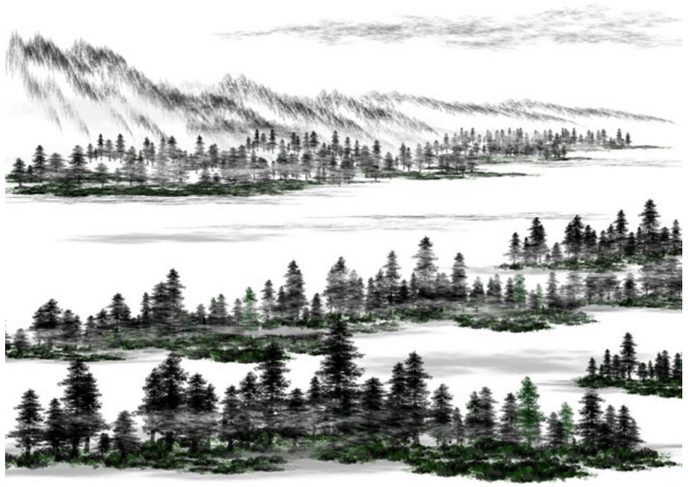


Parrots
16" x 13"
Digital print



Chaotic landscape paintings
13" x 16"
Digital print

A new method by using Structural Cloning Method (SCM) and Leaping Iterated Function System (LIFS) to explore abstractor and landscape painting are presented in these artwork. SCM is a visual interface to define different combinations of geometry transformations and LIFS is an improved version of Iterated Function System (IFS) within SCM. Instead of exponential growing loading while iterating; LIFS takes only constant computing resources. From the viewpoint of visual design, SCM and LIFS together build a bridge between mathematic and aesthetic, and they then make fractals more tractable. However, it is much more challenge to convey a natural feeling in such a painting without the feeling of mathematics.

Parrots • "Parrots" is an attractor of the iterated function system w1(z) = d1*z + c1; w2(z) = d2*z + c2, where c1 , c2 are complex numbers for translation, and d1, d2 are complex numbers for rotation and scaling , "Parrots" is a self-similar image. How many parrots can you tell in this picture? Many duplications of a single one? What are they doing? Each Parrot stands right on the back on another!

Chaotic landscape paintings • Using Strutural Cloning Method and Leaping Iterated Function System, chaotic patterns, rocks, clouds, mountains, fogs, trees, etc, can be designed easily. This picture is a combinations of these chaotic patterns and is compiled on PowerPoint by AMA. Look at this picture carefully, you find that visual elements of the same type are cloned together everywhere, in particular, the structure of clouds, ripples, and fogs are similar.

ANITA CHOWDRY

CONTACT

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Spirals and dragon curves
23"X22"
Digital print of painting on paper

The techniques I use in my paintings are based on my research into the methods and materials of painting and illuminating in Indian and Persian manuscripts. The precision of these techniques works well with mathematically conceived contemporary work, enabling finely defined linear work and highly rendered areas of colour.

I am interested in exploring the aesthetic and philosophical possibilities geometry, finding ways of combining classical forms that structured Islamic geometry with the intriguing organic shapes generated by different types of fractal geometry.

I use mathematics as the primary inspiration in my work because of its inherent beauty and its challenge to make sense of and express what is beyond our normal sensory and emotional equipment.

Spirals and dragon curves • The original painting is created in two layers: the top layer is painted on paper with watercolours and hand-made malachite, pure gold and silver pigments, cut, and placed on a background of gold-flecked indigo dyed paper. A freehand Heighway dragon curve (with acknowledgement to Joel Castellanos' web-based "Fractal Grower") grows out of a Fibonacci spiral which curls in the background into an Archemedian spiral with Arabesques. The cut-out shapes pay homage to the artistic efforts of the many anonymous silverfish who have modified pages of historic manuscripts!

ERIK D. DEMAINE, MARTIN L. DEMAINE, ANNA LUBIW, ARLO SHALLIT, JONAH L. SHALLIT

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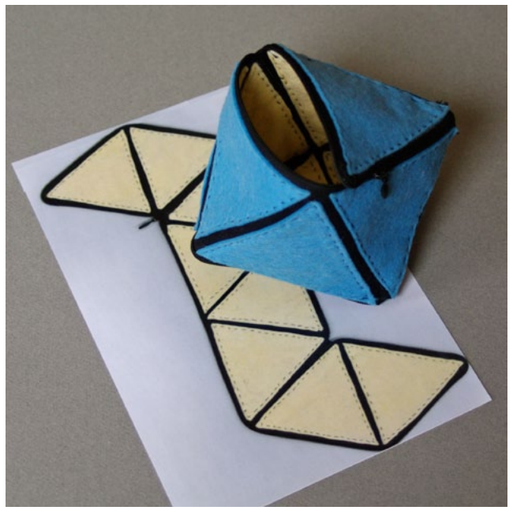

zipper unfolding of an octahedron
5" x 5" x 5" (3d); 12" x 16" (2d)
felt with zipper, plus colour photocopy

zipper unfolding of a double pyramid
5" x 5" x 5" (3d); 9" x 15" (2d)
felt with zipper, plus colour photocopy

This work is a collaboration involving Erik D. Demaine (MIT), Martin Demaine (MIT), Anna Lubiw (Waterloo), Arlo Shallit, and Jonah Shallit. The goal was to do math with family members: Erik is Martin's son, and Arlo and Jonah are Anna's sons.

We were exploring what 3-dimensional shapes can be made from a planar polygon and one zipper. Or, to put it another way, what 3-dimensional shapes can be unzipped to lie flat in the plane without overlap.

Felt models with real zippers are a satisfyingly tangible way to appreciate the problem.

zipper unfolding of an octahedron • An octahedron can be unzipped to a planar polygon. In fact, all the Platonic and Archimedean solids have zipper unfoldings (http://erikdemaine.org/zippers/). Can every convex polyhedron be unzipped to a planar shape? If the zipper is restricted to travel along the edges of the polyhedron, then a Hamiltonian path is necessary (though not sufficient) and the answer is "no". The general question is open.

zipper unfolding of a double pyramid • On the outside, this model is an octahedron. However, it has an extra square face on the inside, so it is really two pyramids glued together on their bases. This two-celled polyhedral complex has a zipper unfolding.

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Artists' studio
15" x 15"
Multimedia on canvas

Mathematics represents the expression of abstract intelligence at its best. It is the fertile ground that inspires me to celebrate both our collective intellectual achievement and the dynamic of its association with our more tangible environment.

The development of computer-based mathematical visualization programs such as Dr Palais' 3D-XplorMath software have been an inspiration and a distinct incentive that encouraged me to develop further my interest in this field.

Artists' studio • Two soliton & Four soliton figures. In mathematics and physics, a soliton is a self-reinforcing solitary wave. Solitons arise as the solutions of a widespread class of weakly nonlinear dispersive partial differential equations describing physical systems. Their characteristics are to be of permanent form and localized within a region. They can interact with other solitons, and emerge from the collision unchanged (Kanehisa Takasaki - Kyoto University). The purpose of this image was to put highly abstract concepts in the perspective of a broader esthetic and cultural environment. The title & composition is a reference to XVIII & XIX century paintings of artists' "ateliers" (David, Delacroix, etc...) (Tools: 3D-XplorMath, Adobe CS5, Pixologic-ZBrush)

Musical box
15" x 15"
Multimedia on canvas

Sonata de Soliton
15" x 15"
Multimedia on canvas

Musical box • Breather & soliton figure variation. Pseudo-spherical Surfaces are being the object of much investigation in the field of music. A breather is a nonlinear wave in which energy concentrates in a localized and oscillatory fashion. Soliton suggests solitary waves that behave like particles. The close relationship between mathematics and music inspired me to create a container for future musical works relating to the soliton and taken after leather bound musical "coffrets" of the court of France in the XVII centruy - as collaboration between the arts was flourishing. (Tools: 3D-XplorMath, Adobe CS5, Pixologic-ZBrush)

Sonata de Soliton • Breather & soliton extracted from Dr Palais's 3D-XplorMath mathematical visualization software. Solitons are very stable solitary waves. When they are located mutually far apart, each of them is approximately a traveling wave with constant shape and velocity. The term breather originates from the characteristic that most breathers are localized in space and oscillate (breathe) in time. The image is built like a visualization of a musical composition: breather orchestra in the background repeating a sustaining theme, breather spheres surging forward to emphasize the theme in targeted sequences and one-soliton solo intervention sprinkled through the performance. The spectator will determine what instrument should each soliton be. (Tools: 3D-XplorMath, Adobe CS5, Pixologic-ZBrush)

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TRANSFORMING CUBE
350 x 350 x 350 mm
Wood, brass

TRANSFORMING POLYHEDRA
At the 2010 Bridges Art Exhibition in Pécs I have presented 3 transforming polyhedra: the cube, the rhombic dodecahedron and the triacontahedron.

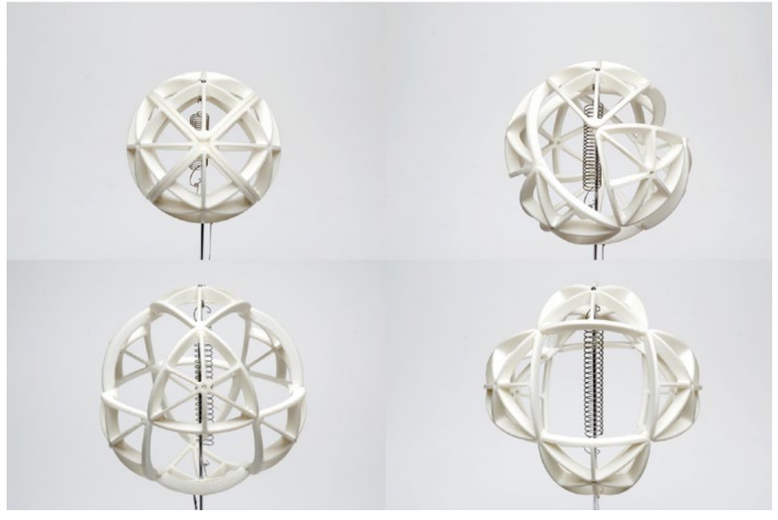
For this exhibition I would like to present three objects that show their movement: from very slow to fast pulsating.

TRANSFORMING CUBE • The edges of the cube are provided with 2 hinges, 24 in total. By turning a lever a diagonal axis moves slowly up and down. The cube open and closes.

"PULSATING" RHOMBIC DODECAHEDRON • The dodecahedron on the picture is suspended in the air with a thin wire. The wire is attached to a metal spring. The edges of the dodecahedron are provided with hinges, 48 in total . Pulling the wire up and down opens and closes the form. With the right frequency the form starts "pulsating". The change in volume reminds of a fast beating heart. The situation can be reconstructed in the exhibition with simple means so that visitors can experience the fenomenon.

TRANSFORMING SPHERE • The sphere is divided in 8 parts. They are connected with 24 axes of rotation. A diagonal spring connects oposite parts. A vertical sliding action opens and closes the sphere. The form is produced by rapid prototyping out of one piece, including the hinges.

"PULSATING" RHOMBIC DODECAHEDRON
Original painting 48"x48", printed as 20"x24" for show
Acrylic paint on wood



TRANSFORMING SPHERE
diameter closed: 100 mm open: 145 mm
Nylon (selective laser sintering)

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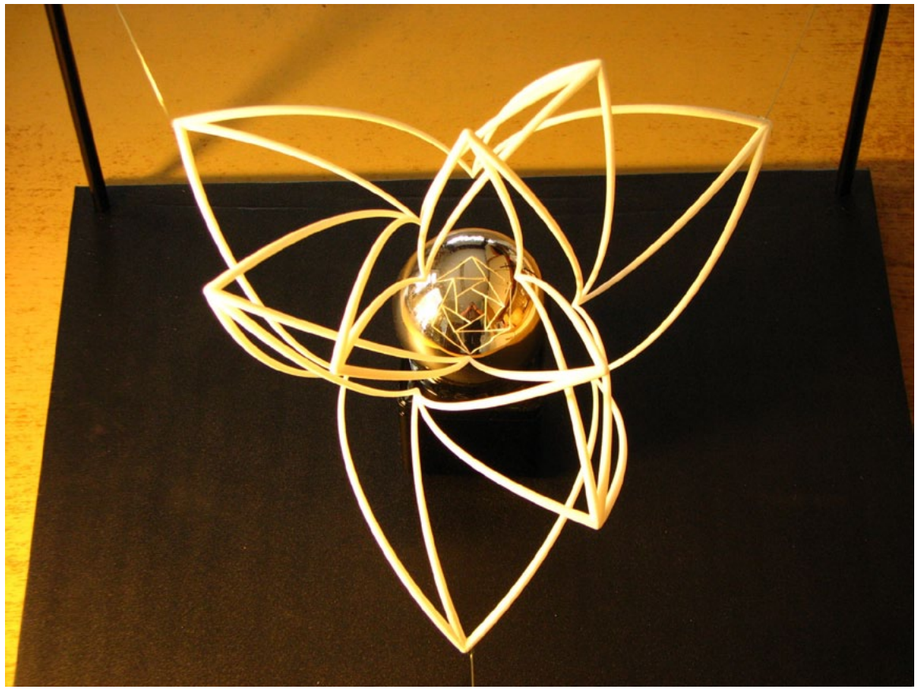


3D anamorphosis
40cmx40cm*20cm
Wood and plastic

Ray-tracing softwares can help you visualize mathematical objects and concepts. The more you become fluent in their language, the more sophisticated objects you can create.

The next step is then to raise those objects to the third dimension, using modeller and 3D-printers.

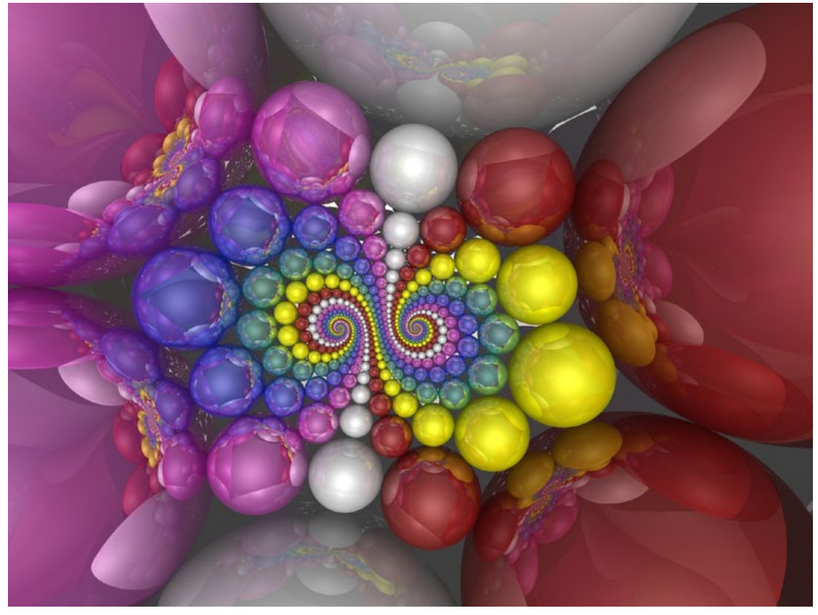
Softwares are my tools, like sculptors have hammers, chisels and gouges.

3D anamorphosis • This work is an attempt to answer the question a British sculptor, James Hopkins asked me : "Is it possible to design a 3D object that will reveal an hidden design when seen in a mirror ?" The answer is yes, and I begun to develop a method for constructing such installations. This is just an appetizer: the research field looks so fertile. I will present a paper about the method I used at the conference.

Inside the Riemann Sphere • A succession of little steps : define a Doyle spiral, invert it in a circle, map it on the Riemann sphere, and finally get inside the sphere. Several layers of spirals, seen from a mathematically forbidden point of view.

The world in a nutshell • Inversion of a Doyle Spiral. There is still another sphere, wrapping all of the others, and tangent to the six border spheres. Can you guess its color ?

Inside the Riemann Sphere
40cmx40cm
Digital print



The world in a nutshell
40cmx40cm
Digital print

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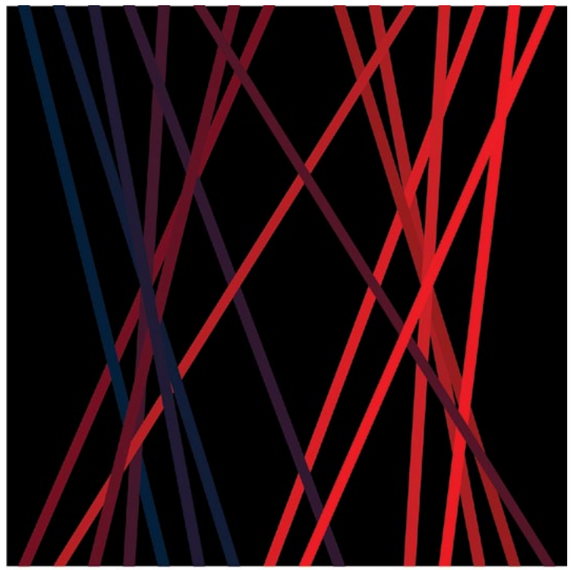

4	11	13	6
5	14	12	3
16	7	1	10
9	2	8	15

H3-magic-square_4_15.01
15" x 15"
print on canvas

For the work presented here, it is assumed, order of some sort is a contributing factor to aesthetic value.

A magic square is known as the arrangement of n x n numbers, such that any column, row or diagonal adds up to the same number. Magic squares are often placed in the recreational corner of mathematics, but they offer interesting strategies to exploit mathematical order for algorithmically generated fine-art.

A project, drawing on magic squares as algorithmic input for the generation of aesthetic events has been carried out in 2010 by artists and programmers at the Media Research Center of Sun-Yat-Sen University in Guangzhou, China. In a joint effort, artists designed schemes for visual representations, and the programmers implemented them. The Center specializes in project oriented joint work between artists and programmers.

In the presented work, we make use of the 4×4 magic square only. Each artist presents one scheme.

H3-magic-square_4_15.01, 8_13.01, 13_6.01 ·
Because of their mathematical properties, magic squares are highly ordered entities. It is our conjecture as artists, that this order will show if transformed into a visual representation. Instead of designing or constructing order for an image, we use the inherent order of magic squares as an engine for the construction of aesthetic events, and we focus on the design of the visualization schemes which generate the images representing those aesthetic events. A great number of such schemes is conceivable. For the example images on display, imagine a 4 x 4 magic square with integers 1 to 16 is rolled out as a linear string on the top and bottom rim of a canvas. Lines are then drawn from top to bottom, connecting 1→2, 2→3, 3→4, … , 15→16. The width, color-range and transparency of the connecting lines and the background color of the images are kept variable, and they are changed within controlled boundaries for each generative run.

8	14	11	1
9	3	6	16
5	15	10	4
12	2	7	13

H3-magic-square_8_13.01
15" x 15"
print on canvas

13	7	10	4
8	12	5	9
2	14	3	15
11	1	16	6

H3-magic-square_13_6.01
15" x 15"
print on canvas

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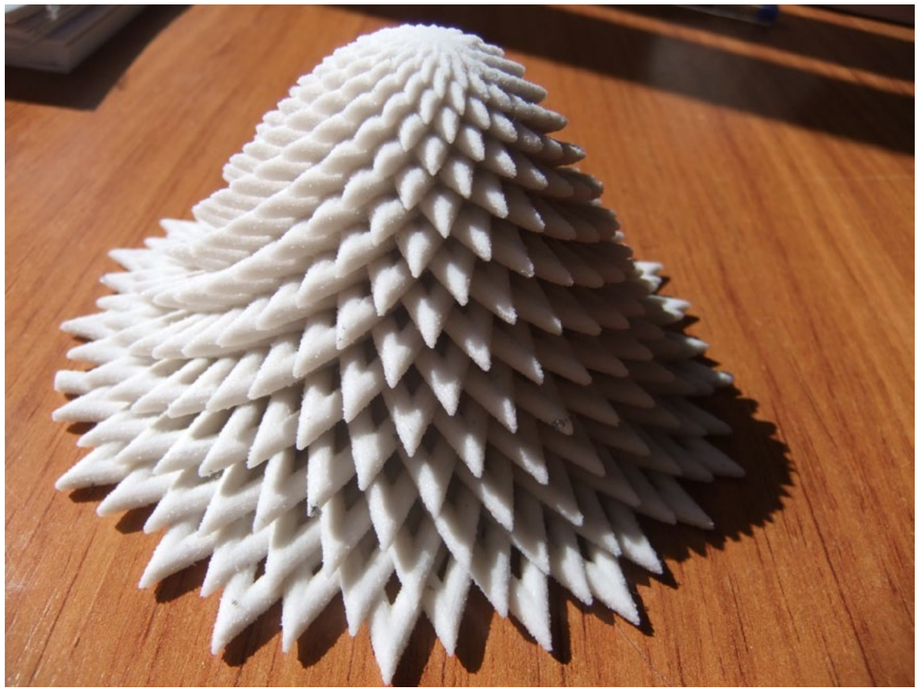


Fibonacci's bell
10 x 10 x 5cm
3d printed on high-density composite

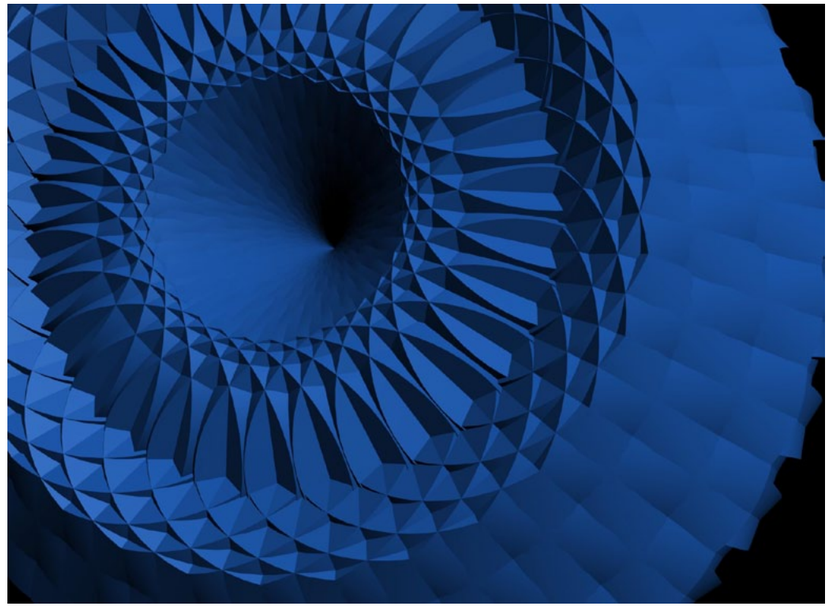
I call my art 'Galician sculptures'. It's a very particular and special kind of three dimensional l-systems, created with my own programs. Currently it is formed by a set of several hundred figures, most of them "wire sculptures" with axial symmetry like tables, exotic dishes or jars with sometimes a geometric profile of Islamic flavor, at other times purely abstract and beautiful objects. Finding rules governing objects and beauty is one of my goals. Finding distinguished and / or spectacular copies, one of my hobbies.

This time Logo 3D production with variable angles was engendered and also a Fibonacci's bell (a simple 3d piecewise curve) following the Fibonacci rules of the flowers.

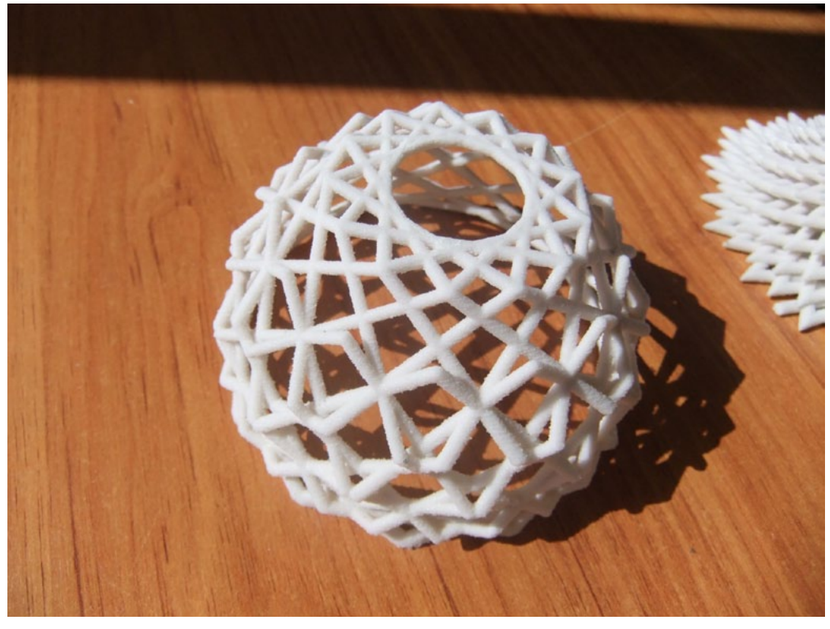
Fibonacci's bell • A figure made with the same formula than pine cones. Pine Cones show the Fibonacci Spirals clearly, like in this artwork. Can you see the two sets of spirals? How many are there in each set? Also the pineapples and pine cones show the same Fibonacci spirit and angle than this artwork. That is a bell because the radius in the plane xy of each point is a cosinus function of the high. Little modifications of this angle give greats changes in the resulting figures like one sense spirals, countinuos spirals, etc.

Wheel • A work of axial symmetry made with a l-system. In the reproduction of the work in a 3d program the internals symmetries give place to a external splendid result with two faces.

Dome • The program used to do this work is very simple (Repeat 1 repeat 12 Repeat 12 fw & end repeat fw + end repeat fw / end repeat) It's a Logo 3D little program of my own that makes a Dome. The 3D angles are 0-30-0 but, and this is the novelty, they are going to change in every repetition. It is the advantage of making your own programs and languages that you can do unexpected things. And this work is one of multiple unexpected things that can happen.



Wheel
10 x 10 x 5cm
3d printed on high-density composite



Dome
10x10x5cm
3d printed on high-density composite

JEANNYE DUDLEY

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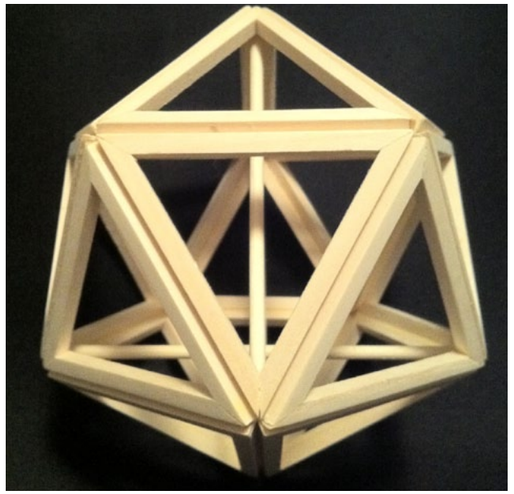
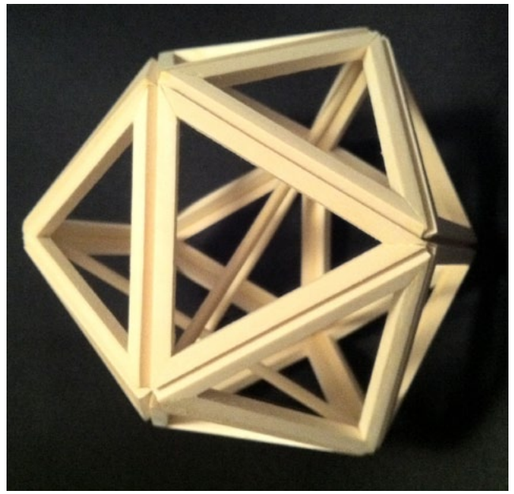


A Study In Proportion and Strength
9" X 9" x 9"
Basswood 3D Geometric Element



Alternate View

After reading Geodesic Math and How to use it; I created a geometric model to study the strength of a tensegrity structure. At the locations for the cables and rods I reverse the material thickness and was amazed that the resulting model was extremely rigid and strong. The dip angle is located at the intersection of each triangle side. With just a line of glue each member begins to work together to resist all forces.

A Study In Proportion and Strength • This model is an example of the dip angle, an inverted tensegrity diagram with three interlocking golden sections inscribed within. It is truly amazing how strong this element is each unit gains the strength of all the others. This model is super strong and rigid.

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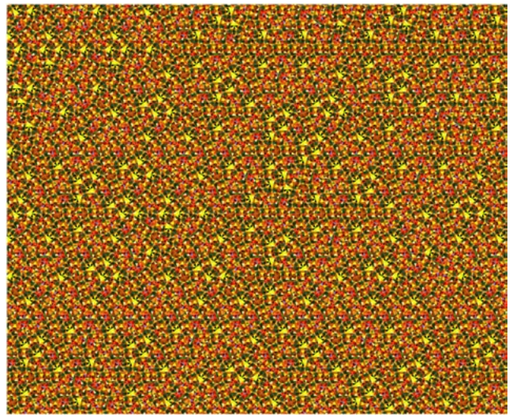
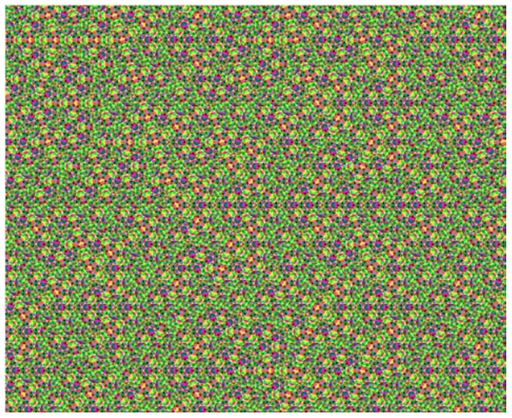


SUPERFICIE RAMIFICADA Va
24" x 30"
Digital Print



SUPERFICIE RAMIFICADA Vb
24" x 30"
Digital Print

Tiling problems have appeared in many branches of mathematics and physics, and during the last few decades there has been much progress in understanding their nature. Research on aperiodic tilings has been very intensive in connection with the field of mathematical quasicrystals. In the visual and sound arts, they have potential interest as systems of reference for channeling the expressive energies.

SUPERFICIE RAMIFICADA Va • This work belongs to a series related to branched manifolds that appear in the study of tiling spaces. A previous work was presented at the 2011 Joint Mathematics Meetings Exhibition of Mathematical Art and was based on a substitution tiling belonging to a random ensemble (Int.J.Mod.Phys.B, Vol.17,n.15,p.2925, 2003, Zbl 1073.52009). The basic shapes here are the two golden triangles that appear in the Robinson decomposition of the Penrose tiling. The substitution rules for the two tiles of the uncollared tiling can be derived with the help of a construction for odd symmetries non divisible by three (Discrete Comput.Geom. Vol.15, p.221, 1996, MR96j:52035, Zbl0849.52016) which was later extended to any symmetry (J.Geom.Phys. Vol.58, p.1451, 2008, MR2010c:52026, Zbl1152.52009 and references therein). In contrast to the Penrose pattern this substitution does not force the border, the first cohomology group of the associated space of tilings is simpler while the second has higher rank.

SUPERFICIE RAMIFICADA Vb • Superficie Ramificada Vb is based on a branched surface that has been defined in order to study topological invariants related to a particular pentagonal tiling. The branched surface is represented in such a way that the triangles with the same shape, color and orientation correspond to the same tile in the CW complex. If somewhere in the tiling a tile shares an edge with another tile, then those two edges are identified. The cell complex contains one hundred and six tiles appearing in five different orientations ("Randomness and topological invariants in pentagonal tiling spaces", Discrete Dyn. Nat. Soc., in press).

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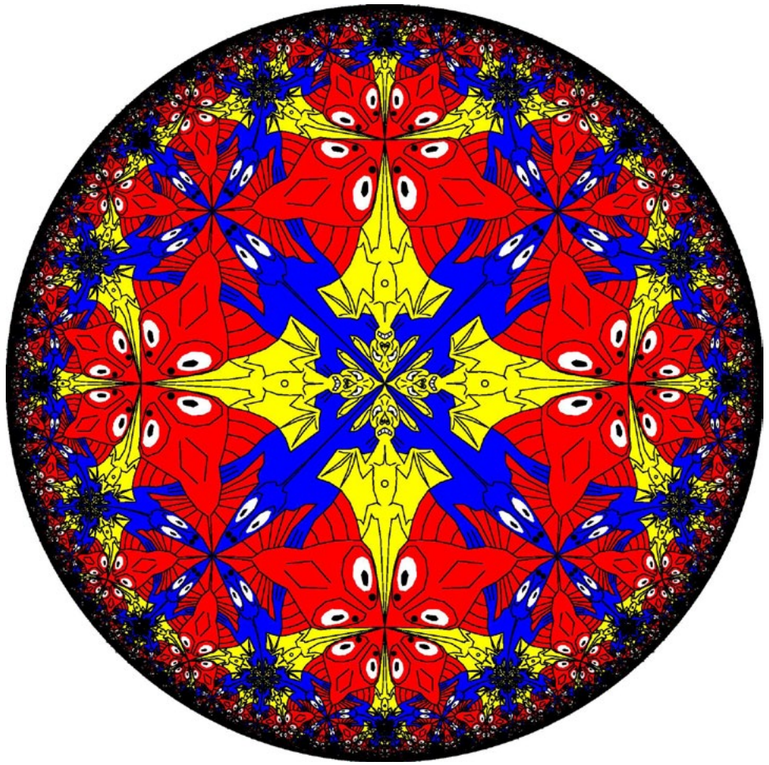
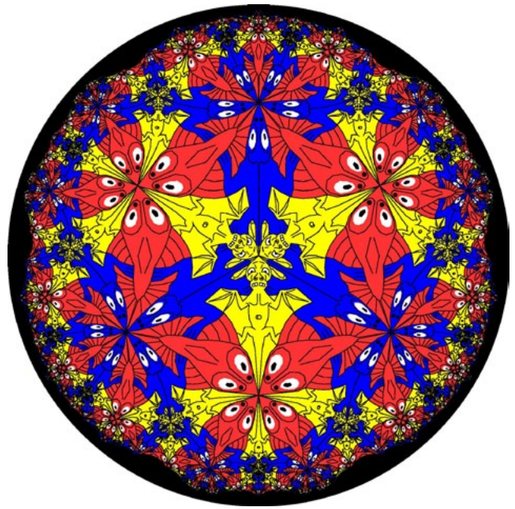


Three Element Pattern 444
11" x 11"
Color printer

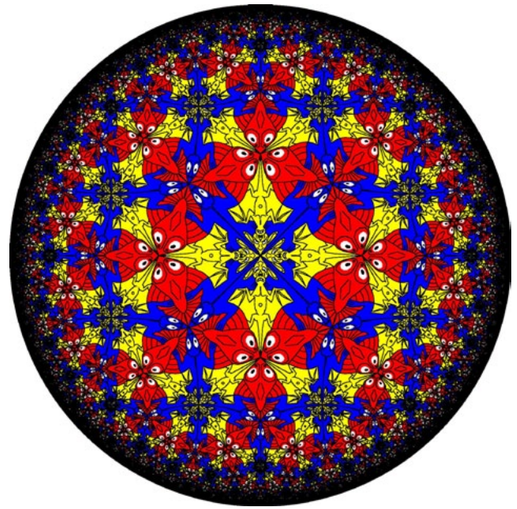
The goal of my art is to create repeating patterns in the hyperbolic plane. These patterns are drawn in the Poincaré circle model of hyperbolic geometry, which has two useful properties: (1) it shows the entire hyperbolic plane in a finite area, and (2) it is conformal, i.e. angles have their Euclidean measure, so that copies of a motif retain their same approximate shape as they get smaller toward the bounding circle. Most of the patterns I create exhibit characteristics of Escher's patterns: they tile the plane without gaps or overlaps, and if colored, they are colored symmetrically and adhere to the map-coloring principle that adjacent copies of the motif are different colors. My patterns are rendered by a color printer. Two challenges are to design appealing motifs and to write programs that facilitate such design and replicate the complete pattern.

Three Element Pattern 444 • This is a hyperbolic pattern consisting of fish, lizards, and bats in the style of M.C.~Escher's Euclidean Regular Division Drawing Number 85. In Escher's drawing, three animals of each type meet head-to-head. The three animals each represent one of the three elements that they live in: the fish, lizards, and bats live in water, on land, and in the air respectively. In my pattern, four of each of the animals meet head-to-head. In general if p fish, q lizards, and r bats meet head-to-head, and $1/p + 1/q + 1/r < 1$, then the pattern must be hyperbolic; if $1/p + 1/q + 1/r = 1$ (as in Escher's Drawing 85), the pattern is Euclidean.



Three Element Pattern 453
11" x 11"
Color printer

Three Element Pattern 453 • This is a hyperbolic pattern of fish, lizards, and bats, as in M.C. Escher's Regular Division Drawing Number 85, with four fish, five lizards, and three bats meeting head-to-head, respectively. Note that the numbers of animals meeting head-to-head is different for each animal. In general if p fish, q lizards, and r bats meet head-to-head, and $1/p + 1/q + 1/r < 1$, as in this case, then the pattern must be hyperbolic.



Three Element Pattern 334
11" x 11"
Color printer

Three Element Pattern 334 • This is a hyperbolic pattern of fish, lizards, and bats, in the style of M.C. Escher's Regular Division Drawing Number 85, with three fish, three lizards, and four bats meeting head-to-head, respectively. In general if p fish, q lizards, and r bats meet head-to-head, and $1/p + 1/q + 1/r < 1$, as is the case here, then the pattern must be hyperbolic.

NICHOLAS DURNAN

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Mobius 3
70 x 240 x 170 mm
English Alabaster

My work is inspired by the beauty of mathematics and geometry. Themes based on the golden section, the mobius strip, borromean rings, the torus and trefoil knot run through my work. These are forms which to me express the the tension of growth and life force through the movement of unfolding, intertwining and twisting. I work with alabaster which is soft, smooth and translucent and takes a fine polish. It is a tactile material which invites the viewer to touch and follow the forms. I collect the raw pieces from Somerset beaches where the weather and sea has already begun the process of shaping the stones.

Influences
Constantin Brancusi, Romanesque sculpture, Barbara Hepworth, mathematics, knots, platonic solids, crystals, Maori art and organic form.

Mobius 3 • Mobius band carved in Somerset Alabaster (from SW England) with a polished finish. Carved completely in the round and can be turned over to reveal similar forms. Very unusual colouring for alabaster which was only fully revealed after polishing.

Borromean Rings 1 • Interlocking Borromean Rings sculpture carved in Somerset Alabaster (from SW England). Polished finish. I was delighted to discover as the work neared completion that a triangle and hexagon were formed from the angles of the rings around the hollowed out centre. The Borromean Rings consist of three circles which are linked in such a way that removing any ring results in two unlinked rings.

Borromean Rings 2 • Borromean Rings sculpture carved from one piece of Somerset Alabaster (from SW England). Polished finish. The Borromean Rings consist of three circles which are linked in such a way that removing any ring results in two unlinked rings.

Borromean Rings 1
190 x 190 x 190 mm
English Alabaster

Borromean Rings 2
50 x 220 x 220 mm
English Alabster

ELAINE KRAJENKE ELLISON

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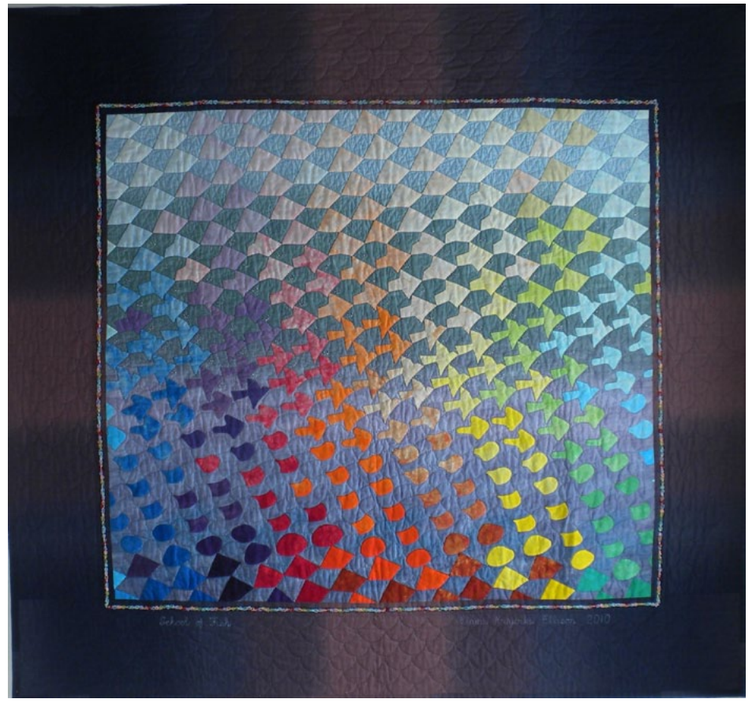
Perspective of Paradise–Six Point Perspective
42.5" x 42"
cloth quilt

The appreciation and demystification of mathematics is a common thread that runs through my mathematical art. After exploring a variety of media including bronze, drawing, glass, and painting, I settled on quilts in the early 1980's. The quilts serve as a visual introduction that allow students to explore mathematics as they gain more insights. As the number of quilts increased each year, I was able to write lesson plans for the quilts. The quilt topics were based on what topics I was teaching at the time—mostly geometry and algebra. From this beginning, Mathematical Quilts and More Mathematical Quilts was published. I have been fortunate to share my love of mathematics with quilt groups, mathematics groups, museums, and various other interested groups. I enjoy meeting the mathematicians that have inspired me over the years at the Bridges conferences.

Perspective of Paradise--Six Point Perspective • This 6 point perspective was inspired by Dick Termes and his work on perspective systems. Two 5 point perspectives are joined together to make the 6 point perspective or 360 view of a Florida landscape. The quilt is two-sided due to the perspective being used. Each side of the quilt has different flora and fauna.

School of Fish • Morphing designs have always been fascinating to me. The quilt was inspired by many creators of such parquet deformations. John Sharp, Craig S. Kaplan, and M. E. Escher had a profound influence on the design of this quilt. The quilt most likely echoes Escher's Day and Night (1938). The fish and the birds delight the eye as they move across the picture plane. Color change also excites the eye.

Perspective of Paradise–6 point perspective (back side)
42.5" x 42"
cloth quilt



School of Fish
53.5" X 49.5"
cloth quilt

ROBERT FATHAUER

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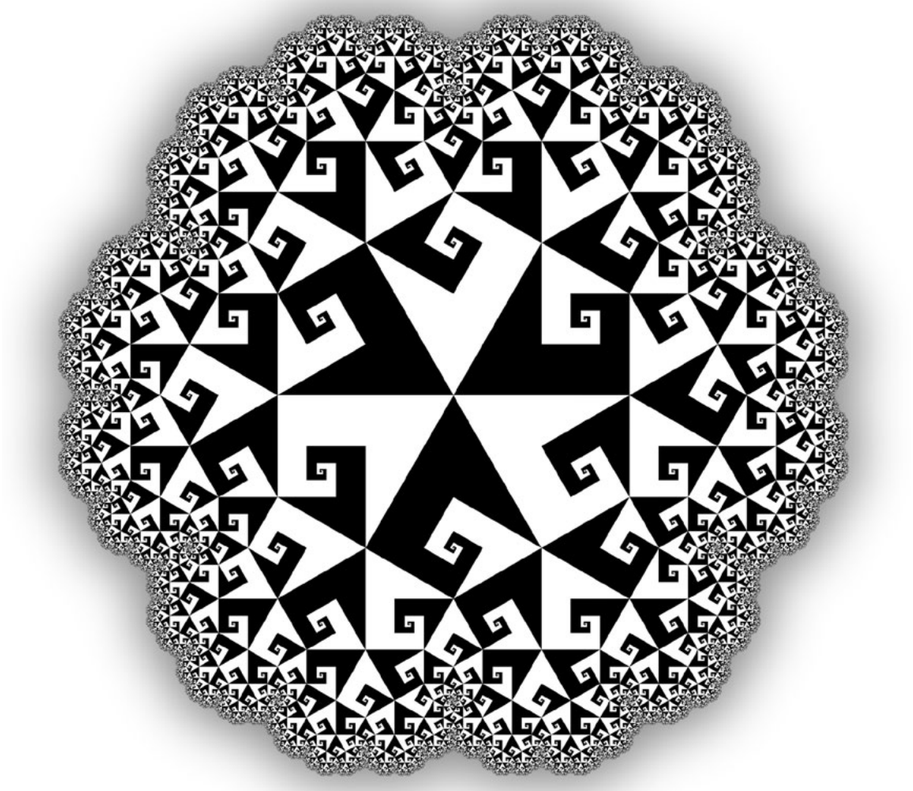
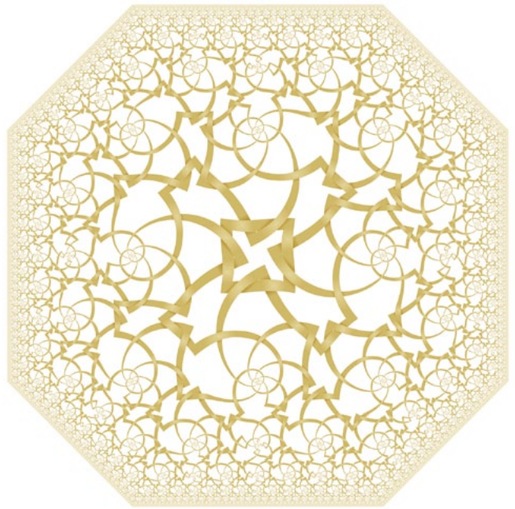


Fractal Tessellation of Spirals
20" x 20"
Digital print

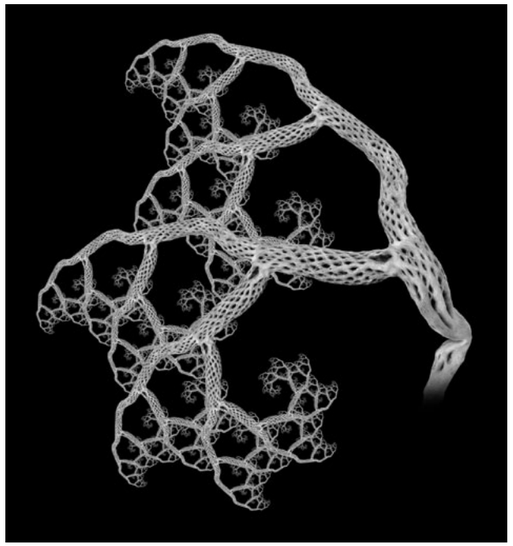
I'm fascinated by certain aspects of our world, including symmetry, chaos, and infinity. The use of mathematics in my art, particularly tiling, fractals, and knots, helps me explore these topics. I combine traditional art forms like phototography with digital techniques to create designs that I feel are an intriguing blend of complexity and beauty.

Fractal Tessellation of Spirals • This artwork is based on a fractal tessellation of kite-shaped tiles I discovered several years ago. Grouping of the kite-shaped tiles into spirals allowed a fractal tessellation to be created in which two colors were sufficient to ensure that no two adjacent tiles have the same color. All of the spirals in the print have the same shape (more precisely, they are all similar in the Euclidean plane).



Infinite Knotted Spirals
20" x 20"
Digital print

Infinite Knotted Spirals • This design was created from a fractal tessellation of spiral tiles. The tiles were decorated with knot graphics to create a fractal design with an infinite number of interwoven spirals. The outlines of the original tiles are not visible in the final design.



Fractal Tree No. 7
20" x 19"
Digital print

Fractal Tree No. 7 • "Fractal Tree No. 7" was constructed by graphically iterating a photographic building block created from photographs of the skeleton of a cholla cactus. The building block was designed to allow seamless mating of smaller to larger copies, and a sufficient number of iterations were performed that the image is indistinguishable from an infinitely-detailed fractal.

PAUL GAILIUNAS

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Hexagonal Antiprism
3" x 3" x 2"
Plastic strapping mad weave.

I have participated in every Bridges conference since 2000, and exhibited artwork since 2007, usually related to my conference presentation. I am interested in any visually interesting manifestation of mathematics, and have used a variety of media at various times: paper or card models, geometrical drawings, computer images, and I have used mathematically inspired designs in leather bookbindings. The use of basketry is fairly new to me, although I have played with one or two ideas over the years.

Hexagonal Antiprism • A hexagonal antiprism created in basketry. The underlying structure is an open hexagonal framework made from two strands of plastic strapping (one green, one red). The framework has been filled-in by weaving two red strands parallel to the green and two green strands parallel to the red to complete a mad weave basket. Hexagonal weaves are chiral, inducing a marked chirality in the colouring of the polyhedral basket, most obviously in the helical patterning of the sides.

Three Strand Tetrahedron • A mad weave tetrahedron created using only three strands. If the strands in a basketry polyhedron are skewed relative to the edges they will follow quite complicated paths in general, but in the case of the tetrahedron they maintain a (more or less) constant direction, taking an approximately helical path between pairs of opposite edges. This means that it is possible to weave tetrahedra with only three strands.

Decorated Tetrahedron • A mad weave tetrahedron woven from six strands. The constraints implied by the symmetry of the tetrahedron and the geometry of skew mad weave limit the possibilities of colour symmetry. In this example the first impression is of a random pattern, and the symmetries only become apparent after careful study.

Three Strand Tetrahedron
2" x 2" x 2"
Plastic strapping mad weave.

Decorated Tetrahedron
4" x 4" x 4"
Plastic strapping mad weave.

MEHRDAD GAROUSI

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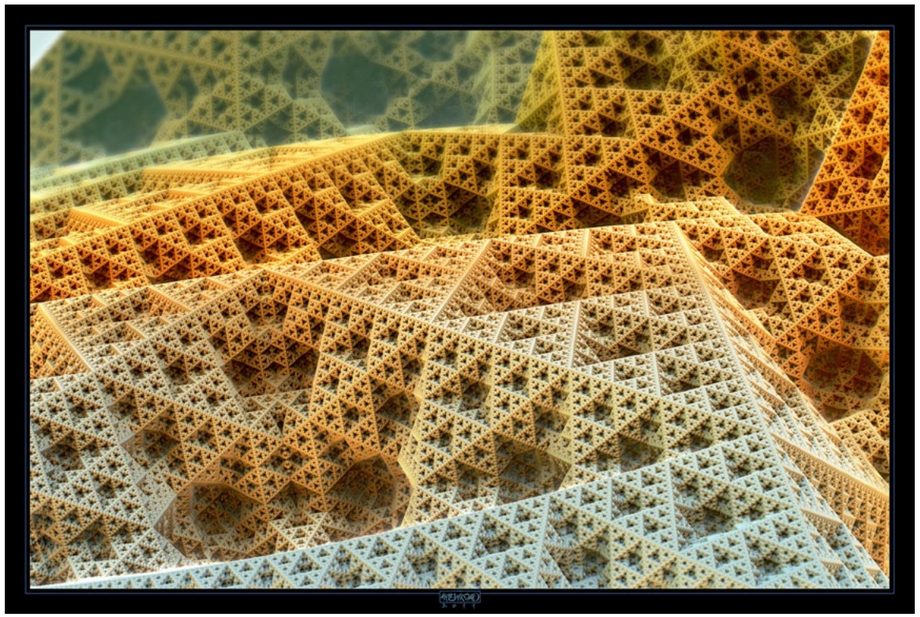

Triangles World
20" x 30"
Digital print

Discovery of a way of representing 3D exposures of fractals, with fractional dimensions, digitally was an astonishing landmark that opened new doors toward unknown worlds more tangible for us observing and understanding in a 3D manner. One of the wonderful pieces of software which allows this type of 3D explorations in fractal worlds is Mandelbulb 3D to which I have got addicted for months. All my works seen here are created by this amazing software.

Triangles World • This 3D environment, entirely constructed in accordance with Sierpinski triangular pattern, represents a dream land for Sierpinski lovers. This fractal is made up of a mixture of four different fractal formulas (some of them are hybrid formulas that really do not remind of any standard fractal and their names are only meaningful in Mandelbulb 3D), each one showing its particular properties visually effective in certain cycles of iterations during magnifications. The main initiator of this fractal has been an icosahedron we are looking at a blown up portion of which at a 5.544 E7 magnification.

Biscuit Land
20" x 20"
Digital print

Biscuit Land • This work exposures a fractal ensemble floating in space with materials reminding of biscuits. Mathematical structure of the mass has worked according to two tied ways of iterating: one that slices and hatches cubes of materials vertically and horizontally and the other one that drills the center of the front face of every sliced cube. Drilled areas are distinctive with the remaining orange cubic shapes at their centers. The simplicity of iterations at first might inspire a wholly ordered scene, but minor changes in the formula have caused more complexities and chaotic behaviors to appear; especially, in drilled areas and the distant portions lying in the glowering background. Blurred distant stuff also shows that we are in the middle of an erstwhile continuous iteration at some magnification.

Space Shelter
20" x 20"
Digital print

Space Shelter • This fractal environment has been created with a well known formula in Mandelbulb 3D named "Amazing Box" which provides rectangular surfaces placing on larger similar ones and sometimes arranging in form of half-spheres. Such a self-similarity has provided this bizarre landscape under the shining sky.

GARY GREENFIELD

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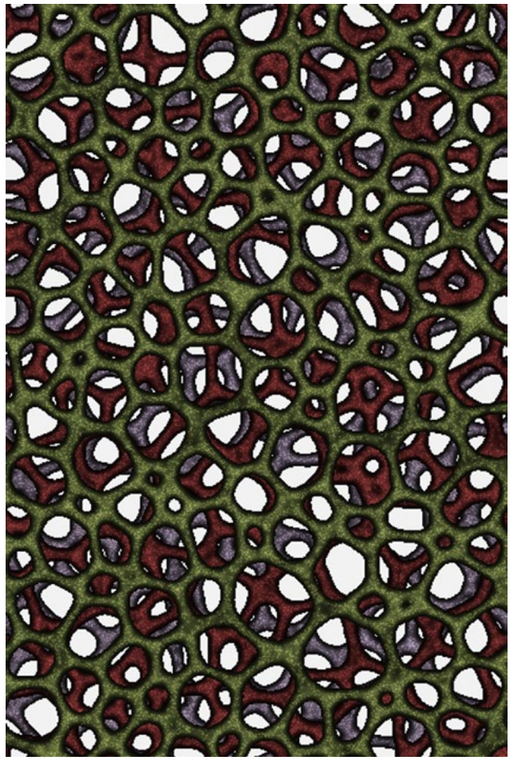
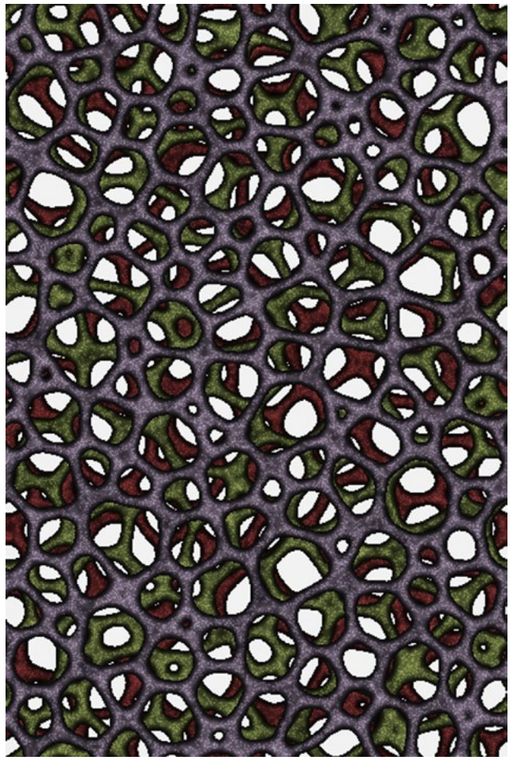
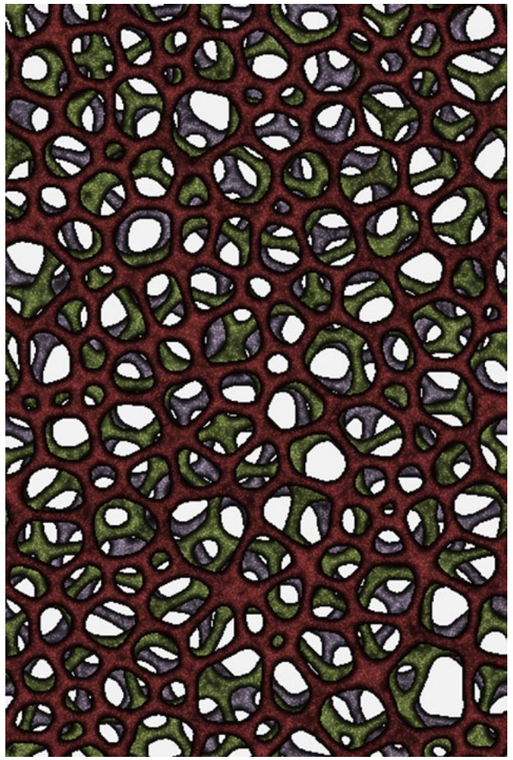


Transport Network Overlay #531
6" x 4"
Digital Print



Transport Network Overlay #9727
6" x 4"
Digital Print



Transport Network Overlay #15037
6" x 4"
Digital Print

Many of my computer generated artworks are based on simulations that are inspired by mathematical models of physical and biological processes. In exploring the space of parameters that govern the simulation, I try to focus the viewer's attention on the complexity underlying such processes.

Transport Network Overlay #531, #9727, #15037 · Each layer of these three-layer overlays is obtained by pseudocoloring the pheromone gradient pattern that emerges when thousands of vitrual ants roam over a toroidal grid. Here, pheromone is a virtual substance deposited by the virtual ants that diffuses and evaporates over time. The critical mechanism underlying these patterns is "remote sensing". In other words, a virtual ant's behavior is governed by pheremone concentrations it senses a considerable distance away from its curent location. This model was first introduced by Jeff Jones to simulate the formation of the transport networks of the slime mold Physarum.

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Transformative Modular Scarf #1
20' x 20" x 20"
Laser cut nonwoven fabric

As a textile designer I became interested in developing interchangeable modular systems that promote sustainable design. Inspired by fundamental geometric structure and patterns of growth in nature, I have explored concepts of symmetry, tessellations and fractal geometry in the creation of modular patterns and shapes for practical application in textile and fashion design. These modular pieces, which can be combined or taken apart at the will of the consumer, are used to explore a practice that encourages the end-user to participate in design process through a flexible approach to the creation and transformation of textile products.

Transformative Modular Scarf #1 • Developed from the tessellation of equilateral triangles, these modular textile pieces can be constructed in a variety of ways allowing the user freedom to personalize the design through playful experimentation.

Transformative Modular Scarf #2
20' x 20" x 20"
Laser cut nonwoven fabric

Transformative Modular Scarf #2 • A modular design for a scarf based on a tessellation of interlocking square pieces. The design encourages the end-user to participate in design process through a flexible approach to the creation and transformation of the product.

Transformative Modular Scarf #3
20' x 20" x 20"
Laser cut nonwoven fabric

Transformative Modular Scarf #3 • A modular design for a scarf based on a tessellation of interlocking hexagonal pieces which can be combined or taken apart at the will of the user.

BJARNE JESPERSEN

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Royal Family
Ø 60 mm, Ø 75 mm, Ø 80 mm, Ø 100 mm, Ø 105 mm
Wood

I use creative geometry to bring new life to old traditions of "magic woodcarving", i.e. the art of carving a piece of wood into parts that are loose, but cannot be separated. Traditional examples are wooden chains and balls in cages, as seen in such items as Welsh love spoons and European wool winders. Next year a book will be published by Fox Chapel Publishing Company, explaining my carving technique and the geometric methods I use to develop my models.

Royal Family • The five pieces share a basic weaving pattern which is symmetrically repeated in five different ways according to a technique using rhombic polyhedra, as explained in my Bridges paper last year and used again in this year's paper. My titles for the individual pieces are Triple Whitehead, Wave Packet, Tetracoil, Halo, and Hexacoil. The numbers of components in each are three, six, four, ten, and six.

MERRILL LESSLEY

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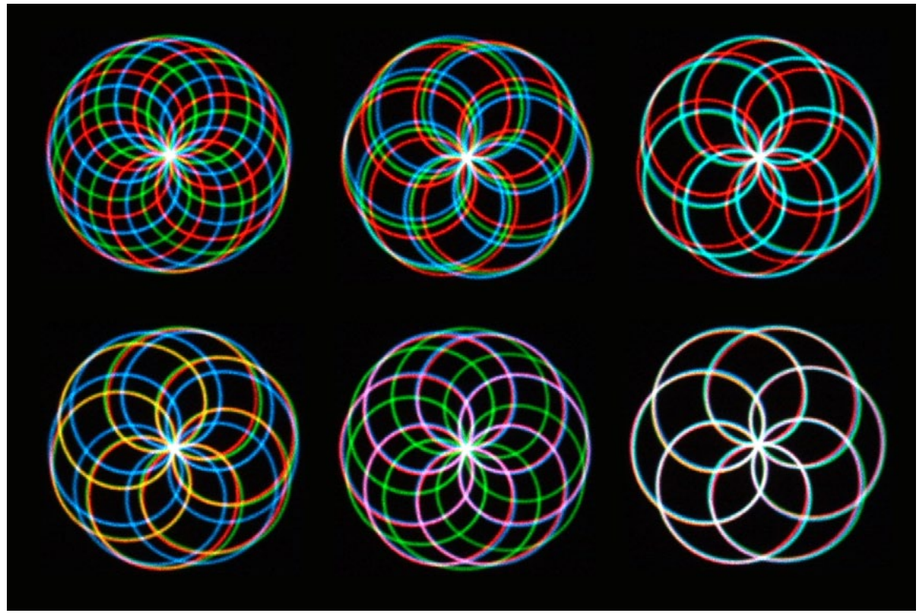

Laser Rose
12" x 18"
Archival Inkjet Print

In my interdisciplinary research and creative work, I create laser images in motion that represent specific mathematical curves (epicycloids, hypocycloids, roses, epitrochoids, hypotrochoids, and other special sine/cosine cases). These images are created by using a computer-controlled laser projection system that I have designed and built. Graphing such curves in multiple laser colors produces a wide variety of images that are really quite beautiful. Unlike drawing them on paper, however, projecting such curves with a laser, or several lasers, poses a particularly challenging problem: while a laser is often referred to as a kind of "pencil" in light, it can only be used to generate a complete picture by moving its projected "dot" rapidly and repeatedly over a reflective surface. The images I create must be scanned at rates between 15 and 2000 times per second. My primary goal is to create computerized tools that can be utilized by laser artists throughout the world.

Laser Rose • "Laser Rose" was constructed by applying mixtures of sine and cosine signals to three lasers programmed to scan rapidly on "X" and "Y" axis lines moving rapidly in various directions. These images represent a sequence of photos extracted from a high-resolution video recording of the lasers scanning a six petal rose curve. Creating the art required a mathematical approach similar to the graphing of any hypotrochoid curve. However, since we use base and trace oscillators to form images, traditional parametric equations were modified to accommodate the "dynamic" scanning process. Revised equations considered both base and trace frequencies: $x = (a-b)\cos(\omega t) + h\cos(((a-b)/b)\,\omega t)$; $y = (a-b)\sin(\omega t) + h\sin(((a-b)/b)\,\omega t)$. Also, $\omega = 2\varpi f$, where the base frequency f is the number of times per second that the base oscillator completes a cycle. Since the rose curve is a special case of the hypotrochoid function, $a = (2n)\,h/(n+1)$, $b = (n-1)/(n+1)\,h$, where n is the number of petals.

RICHARD KALLWEIT

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Minimal surface triacontahedron with infinite pentagonal regression
10 in.x 10 in. x 10 in.
offset print , paper

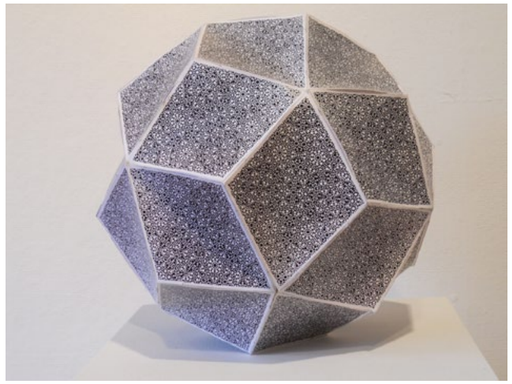
My artworks are based on investigations into mathematical form concerning the arrangements of units in space. Cubic packing,tesselations,symmetry,and growth patterns are some the ideas I've been working with.

These works were developed over long periods of time using these mathematical ideas and some of my own device .The main struggle is to get them to work in the old fashioned sense of beauty, harmony and finish (or lack of).

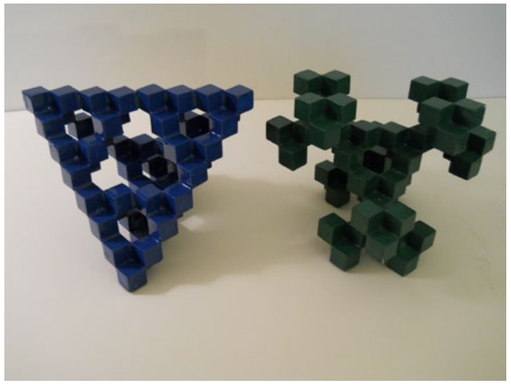
The paintings and structures are sometimes based on such rigid systems they oft feels as if they create themselves as natural phenomena from logical sequence.

This approach has entailed difficulties in that the balance between experiment,research and art is never strictly defined..

minimal surface triacontahedron (I think) with infinite pentagonal regression • This work consists of two interrelated but separate ideas. There is the polyhedra based on the triacontahedron of 30 faces with a minimal surface and the surface itself with its infinite regression star pattern with its 4 colors. I used the 72 degree lozenge shape from the star pentagon (the purple diamond) and with 30 of these constructed the polyhedra. The concavity of the surface resulted from forcing the pieces together.



Triacontahedron with star pattern
12 "x 12 " x12"
paper with off set printing



NEGATIVE / POSITIVE intersecting tetrahedra
5" x5" x5" and 5" x5" x5"
wood paint

Triacontahedron with star pattern • Polyhedron with star pattern is a work resulting from the accumulation of many processes. The faces are formed from thirty diamond shapes of the pentagonal lattice. The surface star pattern was derived from pentagonal units added together; mechanically reduced; added together and reduced again. The construction of the piece is also to be considered part of the piece itself.

NEGATIVE / POSITIVE intersecting tetrahedra • These two pieces need to be counted as one work in that they demonstrate the fusion of two tetrahedra. Here 4 cubes are joined on edge to form a tetrahedron then 4 joined again in a fractal system. The second set is the negative of the first. I later found that similar work has an antecedent in the French priest mathematician Rene Hauy in 1801 . With just some playful joining of cubes I have chanced upon some interesting shapes and ideas.

MARGARET KEPNER

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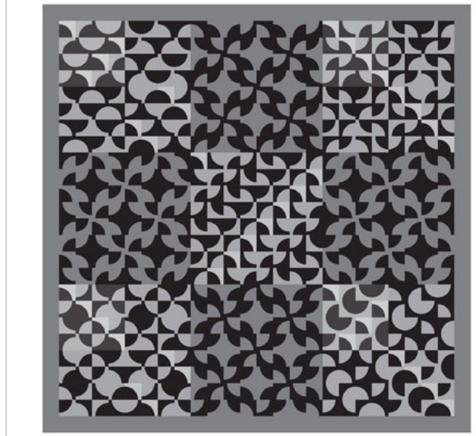
Prime Goose Chase
18" x 18"
Archival inkjet print

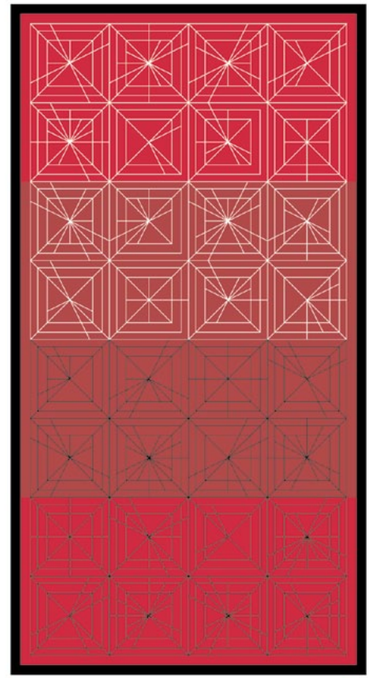
I enjoy exploring the possibilities for expressing ideas in new ways, primarily visually. I have a background in mathematics, which provides me with a wealth of subject matter. My lifelong interest in art gives me a vocabulary to utilize in my work. I particularly like to combine ideas from seemingly different areas and try to find parallels and relationships. Some years I ago I coined the term "visysuals" to describe what I do, meaning the "visual expression of systems" through attributes such as color, geometric forms, and patterns. Topics that I have explored include: tessellations, symmetry patterns, edge-matching, group theory, dissections, magic squares, modular systems, knots, fractals, and number theory. For the most part, I use inkjet printing to produce my artwork. I have also experimented with screen printing, textile constructions, digital printing on fabric, and book making in order to produce pieces at a larger scale and/or with more physical variety.

Prime Goose Chase • This structure of this design is a based on traditional quilt patterns, (Flying Geese, Wild Goose Chase), while its content relates to the Fundamental Theorem of Arithmetic. The integers from 1 to 256 are the "geese," and the prime decomposition of each integer is shown using colored triangles. There are 8 columns of numbers, starting with a black triangle representing 1 at the upper left. Solid triangles are used for primes, and each prime is assigned a unique color: 2 = red, 3 = gold, 5 = yellow-green, …, 19 = magenta. As larger primes are needed, more colors are created by adding white to the basic 8 hues. Composite numbers are represented by subdivided triangles. Since 6 = 2 x 3, it is half red and half gold. Powers of primes are shown using horizontal shades of the base color. Background colors and lines provide additional information. This design is a visual table, allowing number patterns and properties to be studied -- for example, the distribution of the prime numbers.



Eightfold Path
18" x 18"
Archival inkjet print

Eightfold Path • This work is a visual presentation of the 5 non-isomorphic groups of order 8: C8, C2 x C4, C2 x C2 x C2, D4, and Q8. It employs a visual vocabulary derived from a traditional quilt pattern, Drunkard's Path. Each of the small shapes used in the design is a quarter circle in a square, scaled so that its area equals the square's residual area. Combining 4 orientations and 2 colorings yields 8 basic shapes. These are used to form the quilt pattern shown in the 4 large squares at the top, bottom, and sides. The same basic shapes are combined to generate the group tables appearing in the remaining 5 large squares. The 3 Abelian groups appear along the anti-diagonal, with the cyclic group, C8, in the center. The same basic shape represents the identity elements in all tables, and color accents are used to highlight their positions. Except for C8, the group elements in each table have been arranged so that a normal subgroup of order 4 appears in the upper left quadrant of the table.



ELOP Mod 4: Two Ways
18" x 12"
Archival inkjet print

ELOP Mod 4: Two Ways • This piece is derived from a family of binary operation tables expressed in a visual format. The term "ELOP" comes from "elementary operations" and "mod 4" means modulus 4 arithmetic is used. The symbols representing the underlying numbers are triangle slices; for example, the number "3 mod 4" would be shown as a 3/4 slice of a triangle. Six operation tables are shown in a compound table of nested squares, with inverse operations paired together and both possible operand orders expressed. The original design consists of solid shapes, and the overall effect is an array of jagged pinwheels. In this version, however, only the outlines of the shapes are shown. The square web of white lines at the top represents the compound table with addition/subtraction in the inner squares, multiplication/division in the middle square rings, and exponentiation/roots in the outer square rings. In the bottom square, with a web of black lines, the nesting order of the operations has been reversed.

TEJA KRASEK

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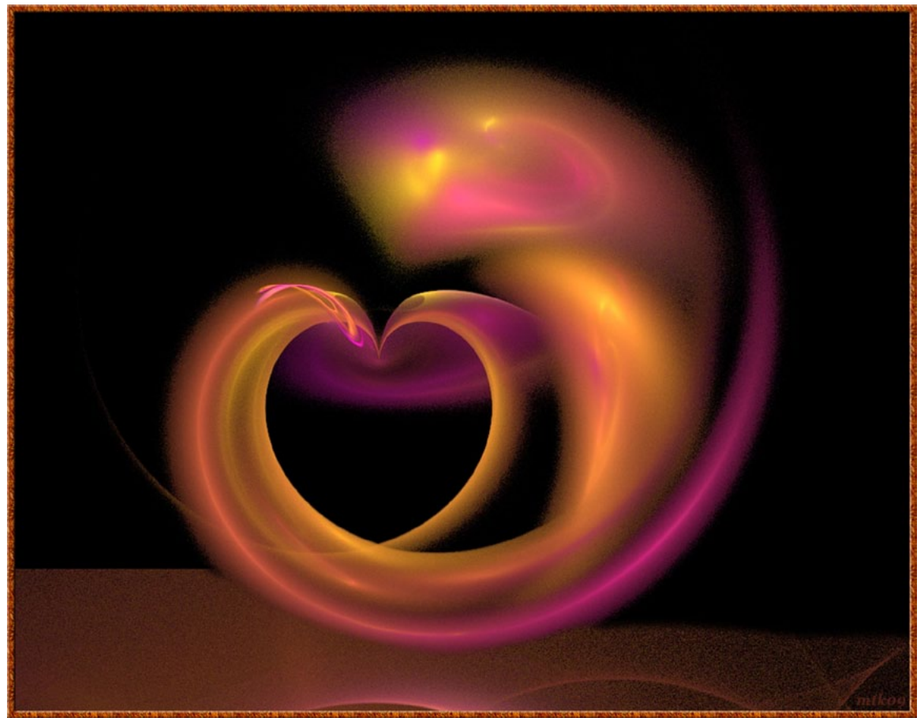

Togetherness
200 × 255.5 mm
Digital print

Krasek's theoretical, as well as practical, work is especially focused on symmetry as a linking concept between art and science, on filling a plane with geometrical shapes, especially those constituting Penrose tilings (rhombs, kites, and darts). The author's interest is focused on the shapes' inner relations, on the relations between the shapes and between them and a regular pentagon. The artworks among others illustrate certain properties, such as golden mean relations, selfsimilarity, fivefold symmetry, Fibonacci sequence, inward infinity, and perceptual ambiguity… Krasek's work concentrates on melding art, science, mathematics and technology. She employs contemporary computer technology as well as classical painting techniques. Her artworks and articles are exhibited and published internationally. Krasek's artworks are among the winners of the 2nd, 3rd, and 4th International NanoArt Online Competition.

Togetherness • In the mysterious world of chaos and strange attractors, a seeker can find delicate, beautiful, and very heartful phenomena...

Lovely NiO Candies • The artwork illustrates the interaction between art, mathematics, and contemporary computer technology, and nanotechnology.

9 Lucky Stars • The artwork depicts an arrangement of 9 pentagonal stars at different size scales as found in a thick Penrose rhomb (cut in half and placed horizontally). We observe a richness of golden mean relations and self-similarity. The fractal pattern of the texture corresponds to the fractal nature of the geometrical structure.

Lovely NiO Candies
165 × 225 mm
Digital print

9 Lucky Stars
110.5 × 274.4 mm
Digital print

JAMES MAI

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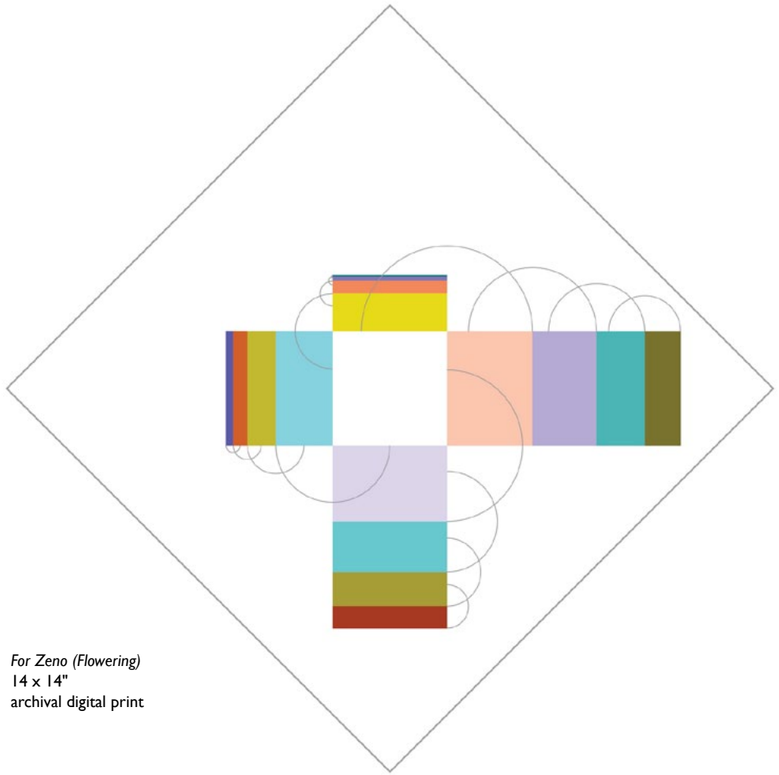


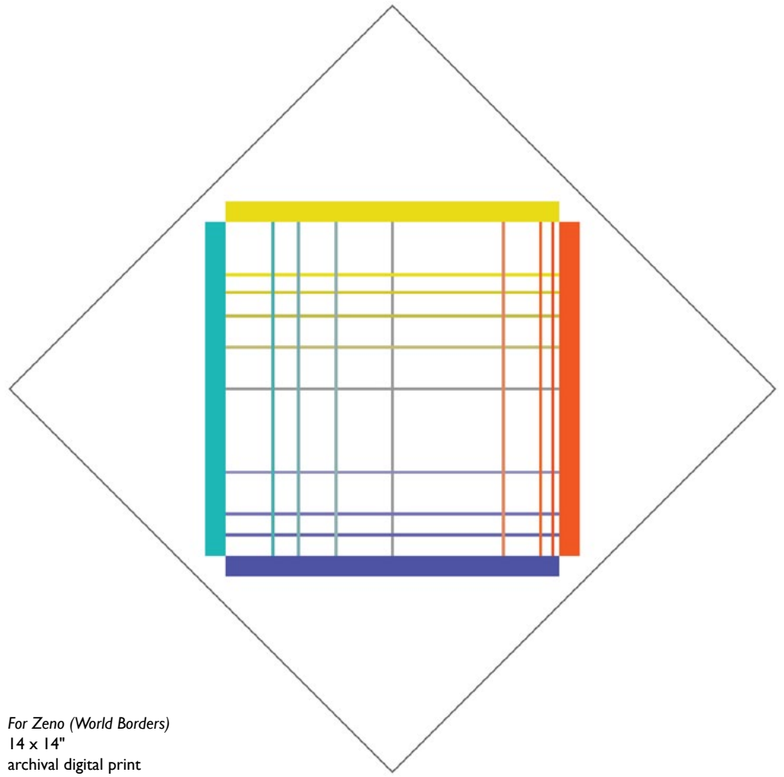
For Zeno (Flowering)
14 x 14"
archival digital print

My work follows two primary directions: color-relativity functions and geometric composition. The color-relativity work examines the structures of simultaneous contrast illusions, whereby a constituent color appears to change its identity in different color contexts. Although this is a purely subjective perceptual experience, the principles by which the illusions function are objectively definable, and therefore manipulable by the artist. Usually I compose within a square format divided by Phi ratio, from which are developed rotational, translational, and reflective symmetries. Other geometric compositions are developed upon grids and are organized by sequences, combinations, and permutations of quantities, shape features, and colors. My studio work explores the boundaries and the overlaps between perceptual and conceptual orders, and mathematics consistently has been integral to that exploration.

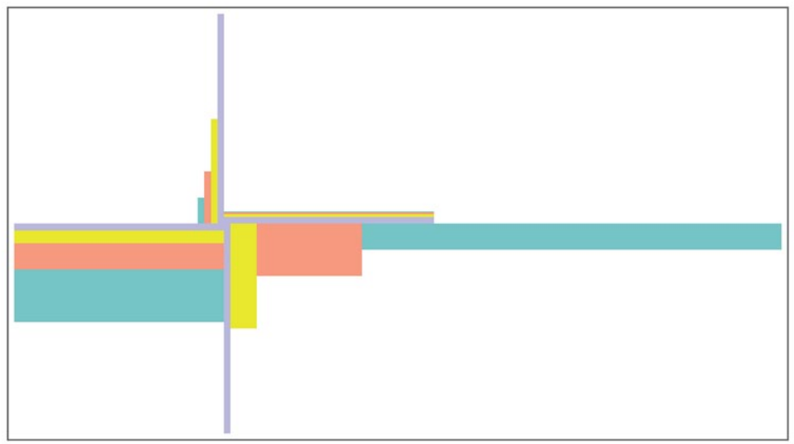
For Zeno (Flowering) • 4 iterations of progressive unfolding from the square; clockwise, beginning from right : 3/4's, 2/3's, 1/2's, 1/3's. 4 sequences of 4 hues (red-orange, violet, cyan, yellow) at 4 values (light, middle-light, middle-dark, dark); light values are adjacent to and dark values farthest from central square; each value stage of each hue rotated counter-clockwise around central square.

For Zeno (World Borders) • 4 iterative divisions from the center lines to the edges of the square; clockwise, beginning from right : 1/3's, 1/2's, 2/3's, 3/4's. Color sequences from gray central axes to high intensity edges; clockwise, beginning from right : red-orange, blue-violet, cyan, yellow.

For Zeno (World Directions) • 4 iterative expansions/contractions of 4 central violet rectangles; clockwise, beginning from top left: halving rectangle lengths with constant widths (halving areas); halving rectangle widths with constant lengths (halving areas); halving rectangle lengths + quadrupling widths (doubling areas); doubling rectangle widths with constant lengths (doubling areas).



For Zeno (World Borders)
14 x 14"
archival digital print



For Zeno (World Directions)
8.5 x 14"
archival digital print

JAN W. MARCUS

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Mandelbrot
210 x 297 x 200 mm
Inkjet print / reflecting cylinder

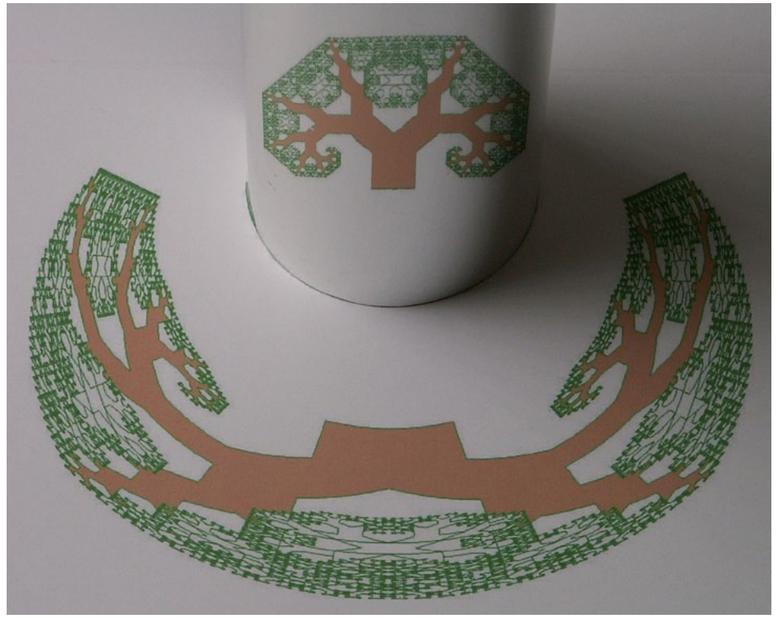
During my professional life as a civil engineer I used mainframe computers as my most important tool. As soon as PCs became available, I did not use them only for analyzing structures but also for making fractals. A small addition to those original software and one can create Cylinder Anamorphosis of fractals.

Mandelbrot • In the reflecting cylinder a Mandelbrot fractal becomes visible.

Sierpinski • In the reflecting cylinder a Sierpinski fractal becomes visible.

Pythagoras tree • In the reflecting cylinder a Pythagoras tree becomes visible.

Sierpinski
210 x 297 x 200 mm
Inkjet print / reflecting cylinder



Pythagoras tree
210 x 297 x 200 mm
Inkjet print / reflecting cylinder

KAZMIER MASLANKA

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Singularity
12 x 12
digital print on paper

The Tao Of Campbell
12 X 12
digital print on paper

"As an artist, my interest in correlating experience through language spawned my desire to study mathematics and physics. I am currently pursuing my interest in using mathematics as a language for art. I serve the concept of polyaesthetics and mathematical poetry by viewing mathematical equations and the variables within the equations as capable of providing the structure for metaphors. Furthermore it pushes the boundary for the use of mathematical equations from the traditional role of denotation into a new role of connotation. Mixing poetics in the structure of mathematic equations enables me to blend the aesthetics of poetry, science and mathematics. With phrases embedded in the mathematic equations, one can construct relationships between the phrases that can bring a linguistic richness to subjects that normally not use mathematics as a language, e.g. cultural, spiritual, etc."

Singularity · The Tao Of Campbell • This is an example of what I call a "Similar Triangle Poem" but could also be described as a "Proportional Poem". The "Similar triangle" idea is used only to help those who are more art oriented to visualize proportions. All of these proportional poems are in the form of "a is to b" as "d is to e". In addition, one of the variables is chosen to be solved and the poem is displayed as a result. The visual images within this polyaesthetic work serve synergistically in the conflation of the mathematical and visual aesthetic experience. The image was created in Photoshop by me using a combination of digital painting techniques and photography.

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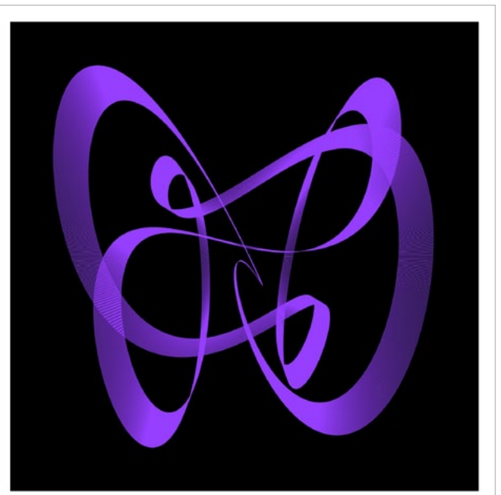
Interruption
11" x 24"
Digital Giclee print



Rococola Redux
18" x 18"
Digital Giclee print

Like other areas where constraint and freedom conflict, the tension between symmetry and asymmetry in mathematically defined or algorithmically constructed objects is where art lies. This interplay is important when trying to find a balance between platonic and aesthetic beauty in any satisfying mathematical art. Even more gratifying is when one's aesthetic explorations of a constrained combinatorial space lead to new mathematical discoveries.

Space-filling curve constructions are threaded tilings (essentially special Hamiltonian paths on grid graphs and their duals) that visually evince this symmetry vs. asymmetry tension. These self-avoiding paths in turn are composable elements of algebraic structures called monoids. Much of my "mathemaesthetic" work combines research into these monoidal patterns and their constraints, followed by algorithmic and/or visual play with the results.

Interruption • This graphically fanciful piece is based on a space-filling curve construction devised by the artist. It starts out with 120 x 120 = 14,400 small square tiles, threaded to form a Hamiltonian path in their dual adjacency graph, much the same way the Hilbert Curve construction linearizes its initial four square tiles. Groups of consecutive, co-linear segments are coalesced, with corners smoothed. The underlying tiling is thrown away. The still self-avoiding result divides the blue and white world into spiral, square, and fingering forms that harmoniously reference each other. The layout and patterns are largely a result of underlying combinatorial constraints, as opposed to purely aesthetic choices on the part of the artist. The mathematics here isn't just a tool or medium. Here, a mathematical constraint system evinces itself as art.

Rococola Redux • The basis of this piece is a compound Lissajous figure called the Pas de Deux curve, made calligraphic by widening the path as a function of distance from the center. The resulting sweep is then drawn directly in PostScript using over 10,000 thin, fixed-width line segments connected into a simple loop using a (then-novel) fill algorithm the artist developed for pen-plotters in the early 1980s. An explanation of the math and history is in the 2011 Bridges paper, "From Lissajous to Pas de Deux to Tattoo: The Graphic Life of a Beautiful Loop". This loop was determined after much experimentation with frequencies, amplitudes, and phases, with an eye towards symmetry, asymmetry, and grace. The light-colored trace over the black background creates a 1960s-era black-light shading effect that gives a mathematically two-dimensional figure a very three-dimensional, dynamic, and mysterious look.

PETER MEIJER

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Möbius strip in 3D (stair-like form)
7,4" x 7,4" x 29,7"
Wood

My aim is to invent simple and beautiful shapes based on a explicit thought. My sculptures are answers to questions, questions like: What happens if ?, How many ways are there to ?, Is it possible to ? and so on. The sculptures are based on formal conditions which are inherent to the design. In each design I try to use a minimum number of lines to get the right shape, while each curved line has to be as simple as possible. I like to deviate from the straight line, but not too much.

Mostly I work in wood.

I mainly use the bandsaw machine in order to create my work.

Möbius strip in 3D (stair-like form) • The model is made of wooden plates (MDF). The inner surface is like a Möbius strip in a stair-like form. The whole sculpture can be seen as a 3D Möbius strip. I will give an textual explanation for the visitors (on A5 format).

3D extension of Möbius strip - beam with surfaces in yellow and red.
5,3 x 5,3 x 24 inches
Wood

3D extension of Möbius strip - beam with surfaces in yellow and red. • On the bean is drawed the cutting line that is the border between red and yellow. The sculpture exists of two separate vertical mirrored halves, what lets manipulated the form, because there are two posible variants.

3D extension of Möbius strip
24" x 24"
Acrylic paint on wood

3D extension of Möbius strip • The white surface has properties of the Möbius strip. Characteristics: Regular form (surface exist of straight lines). Surface of Möbius strip became a body. The form of the inside is the form of the outside. (with a twist , what becomes understandable by manipulating the beam before). Walking along the surface goed as follows: 1) Start at the the bottom with position rightup and go to the left. 2) When passing the border you go from urricht to upside down. 3) By arriving at the bottom again the position is still upside down. 4) After completing the second loop the position is again upright.

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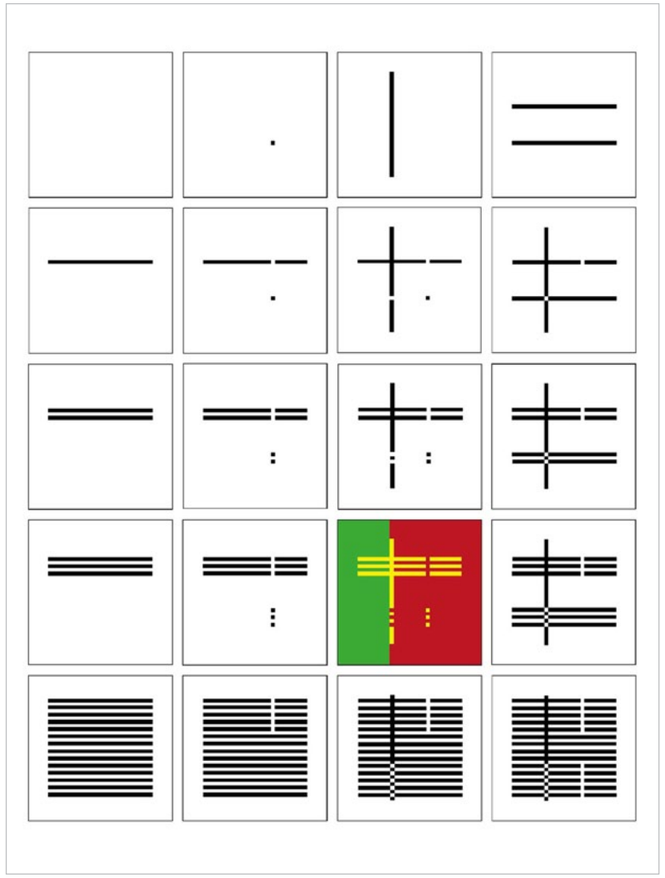
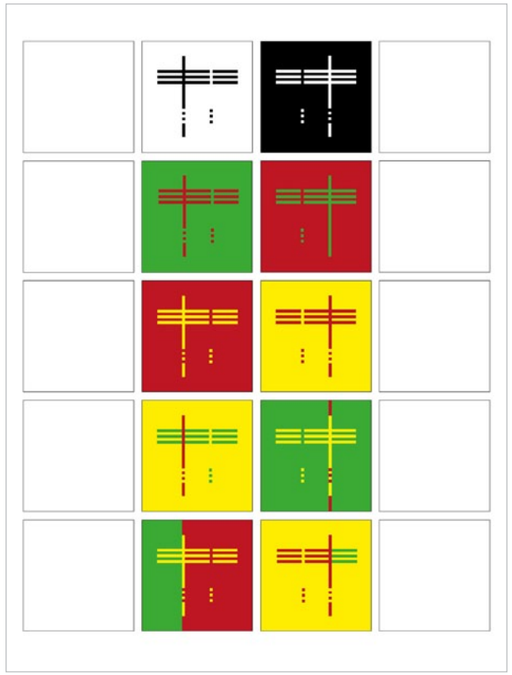


Portuguese Colors 1
400 x 300 mm.
Textile handwoven, design



Portuguese Colors 2
400 x 300 mm.
Textile handwoven, design

Portuguese Colors 3
400 x 300 mm.
Textile handwoven

For me it is fascinating how one can compose a geometric design that starts by drawing a point and a line. In case of multiplication the patterns change while the basic form is still the same. My artwork is based on this kind of mathematical composing. The patterns are built up in points and lines in repeating forms which can be woven by the use of various weaving-techniques. You can modify the patterns endlessly by using different colors.

One of these patterns resembles a flag. By using the colors of the Portuguese flag in the warp (red, green, yellow) I composed "Portuguese colors".

Portuguese Colors 1 • The technique I used in this artwork is warp-faced rep (plain-weave), woven on 8 shafts. Rep is a basic weave pattern which is characterized by prominent ribs in the weft. The warp-threads cover the weft-threads. By alternating two colors you get a front- and a backside in different colors. All my design-examples (1 -20) are woven on the same threading. The difference is made by the way of treadling. I started with an empty square which I gradually filled in with one point, one line and a multiplication of them (2,3, more), together they built blocks.

Portuguese Colors 2 • In these examples is shown that the color changes the design. The front- and the backsides are given in pairs (left end right). The pair at the bottom is inspired on the colors of the Portuguese flag.

Portuguese Colors 3 • Artwork: Functional-Design (pot-holder/trivet 200 x 200 mm.) Material: Cottolin (22/2 Bomull-Lin, Garnhuset i Kinna, Sweden)

CHARLENE MORROW

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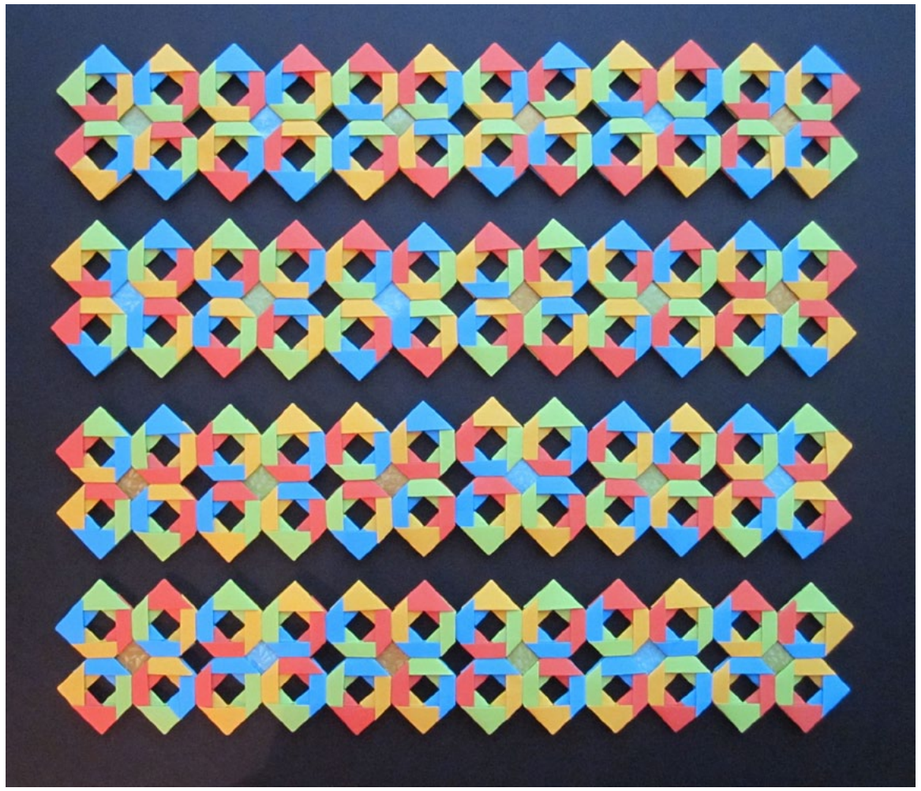

Solar Orbits
4" x 17" (eventual size 16" x 17")
Folded Paper

I work mainly in the medium of origami. I am motivated to understand mathematical ideas that I encounter through the process of expressing them in visual ways. If the results are a visually pleasing piece of art and a deeper understanding of the mathematical ideas I set out to explore, then I am satisfied, but not for long because there is always a new question waiting to emerge.

Solar Orbits • This origami quilt, inspired by a wall drawing by Sol LeWitt, was folded from 408 squares of paper and patterned according to the group theoretic process outlined in the paper submitted for Bridges 2011, "A Group Theory Approach to (re) Contructing Sol LeWitt's Drawing Series IV, #413." The construction involves symmetries of a square, orbits, and permutations. Further information is contained in the submitted paper. The four-color squares are connected with a tab and pocket construction thus no tape or glue holds the quilt together. This version is displayed in four separate sections to emphasize a subtle color sorting that can also be found in the LeWitt wall drawing.

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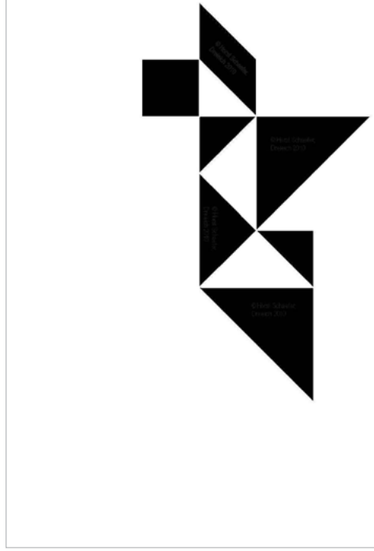
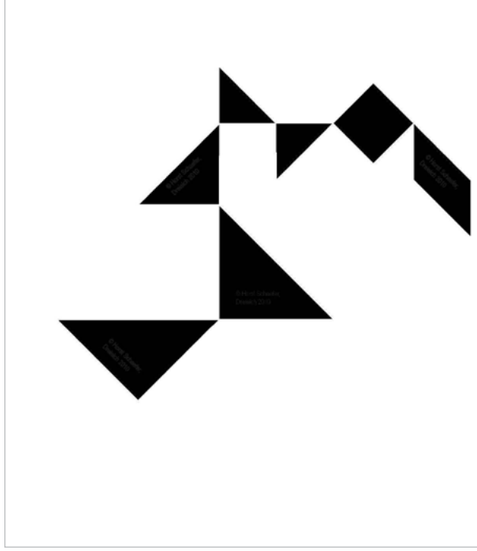


Rule and Form - Rule 06 - Corner are touching each other, in the space in between iscosceles, right-angled triangles arise.
20" x 24"
Intaglio Printing on Paper



Rule and Form - Rule 50 - Chain, corners with an angle of 45 degree are touching corners with a right angle.
20" x 24"
Intaglio printing on Paper

I am trying to apply formal concepts from mathematics, logic or science in my work. I also try to reach a balance between the formal aspects, artistic freedom and the resulting aesthetic value. For me it is essential, that the viewer can be aware of these aspects. As a consequence I am exploring how formal concepts generate a visual form. The name 'Rule and Form' of my first cycle describes this relationship.

Rule and Form - Rule 06 - Corner are touching each other, in the space in between iscosceles, right-angled triangles arise. • The work presented is part of the cycle 'Rule and Form'. The cycle deals with the composition of 7 geometrical figures. The figures are derived from the Chinese Tangram by splitting a square into 7 simple figures (two large triangles, one mid-size triangle, two small triangles, a square, a parallelogram). Each work exemplifies one particular rule. The rules use geometrical properties like corners, sides and angles. Currently 3 series are completed. Composition principle for Series I: Series I has the title 'Surroundings' and contains 19 works. The idea of this series is that the 7 figures of the Tangram surround a geometrical figure. In case of Rule 06, the 7 figures are composed in such a way that they surround three isosceles, right-angled triangles.

Rule and Form - Rule 50 - Chain, corners with an angle of 45 degree are touching corners with a right angle. • Composition principle for Series II: Series II has the title 'Angles and Sides' and contains 23 works. This series relates geometrical properties like corners, angles and sides of the figures to each other. In case of Rule 50, the 7 figures are composed in such a way that one corner of each figure is touching another figure at its corner. The rule specifies the angle at the corner. The notion of a 'chain' is used intuitively, without a mathematical definition. Basically it means that one figure touches at least one and at most two other figures.

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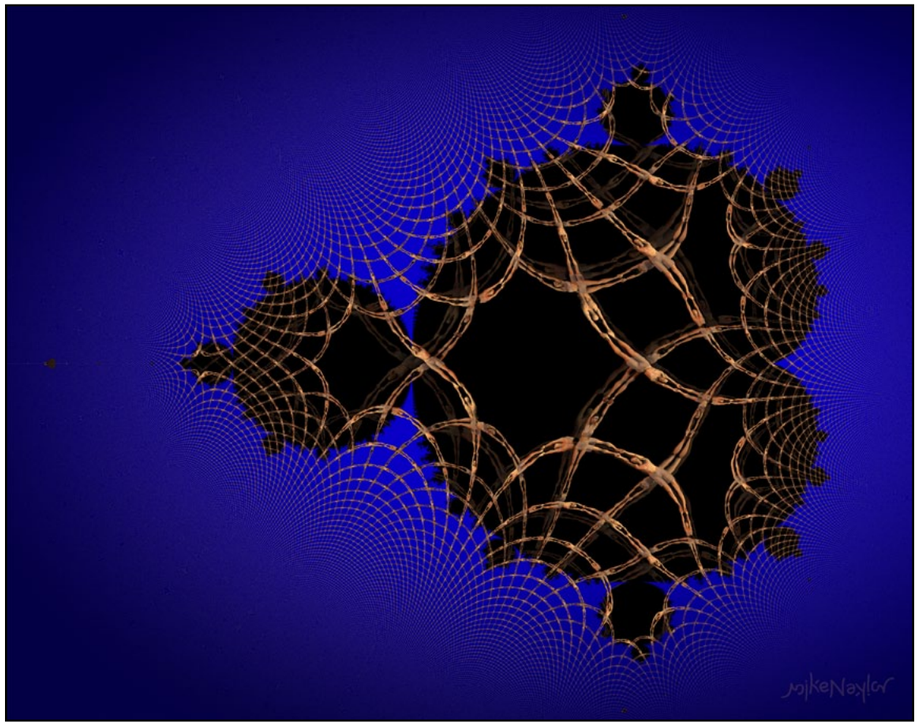


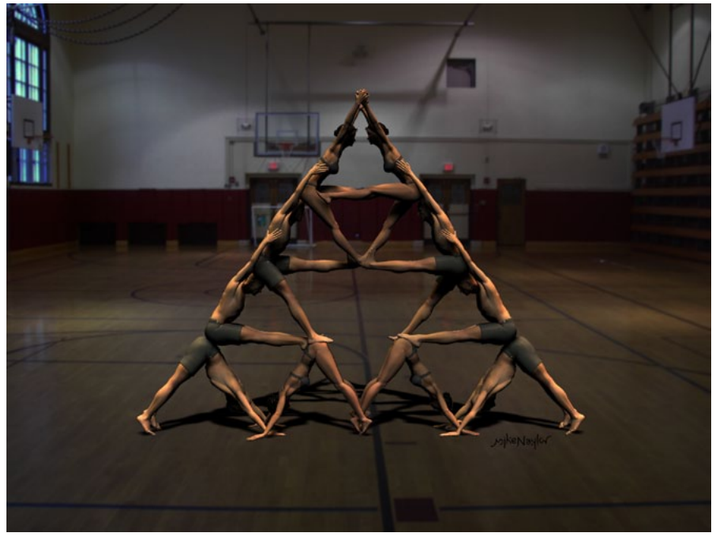
The Human Web
19" x 24"
Digital print

My artwork focuses on creating geometric forms using human figures. The blending of human bodies and mathematical shapes can create a surprising and sometimes surreal effect that makes us feel physically connected to something powerful and important. Mathematics is part of us, and we are part of mathematics.

The Human Web • This work was created in tribute to the late Benoit Mandelbrot. Human lives and relationships are strange and complex things, and the Mandelbrot set seems to capture the essence of strangeness and complexity as few mathematical forms can. "The Human Web" juxtaposes a web of human figures with the Mandelbrot set in order to symbolize the complexity and beauty of our human relationships. The underlying Mandelbrot image was created with Xaos, the human figures created with Poser and arranged into a web using Photoshop. This web was then transformed using MathMap and GIMP, and the various layers were reassembled in Photoshop.

Sierpinski Tower • The second iteration of the Sierpinski Triangle, made from gymnasts. These acrobats were created using Poser and Photoshop, but the physics is sound and a tower such as this could stand.

Pentamen • A pentagram is a five-pointed star. When inscribed inside of a pentagon, it becomes a symbol that was of importance to the ancient Pythagoreans. The inscribed pentagram embodies the golden ratio in many ways and was used in part to identify members of the Pythagorean school. The inscribed pentagram is also the shape of the K5 graph, a complete set of 5 vertices all connected to one another. Here the graph is represented by a group of 5 men, with their legs forming the pentagon, their arms forming the pentagram, and their heads doubtless lost in mystical contemplation of all that is good and beautiful.



Sierpinski Tower
16.5" x 21"
Digital print

Pentamen
16" x 12"
Digital print

CURTIS PALMER

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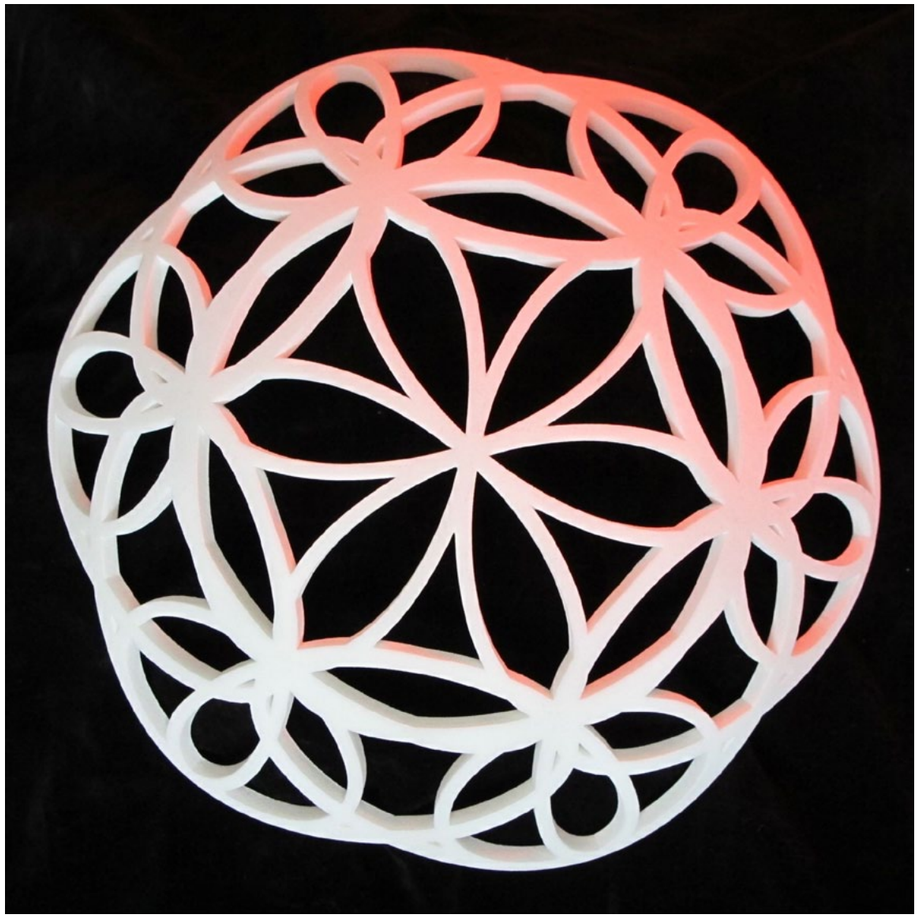

This is not a Chair!
10"x 10" x 4"
Nylon (selective laser sintering)

A career in computer aided design has kept me on a journey fascinated with the articulation of form by industrial processes. With the advent of 3D printing, i. e. selective laser sintering, my Cyclons (Bridges 05, 09) resulting from my CAD work with polyhedra can now become material.

This is not a Chair! • This piece began as a Rhinoceros model of a Rhombic Triacontahedron (RT). A wire frame of the RT is projected to the plane, then converted to spline curves with substantial line width. This is then projected into a sphere cutting it into a unique dome.

ANDREIA HALL AND PRUDÊNCIA LEITE

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Sierpinski's Triangle Revisited
130x160 mm
cotton fabrics and thread

We are interested in linking Mathematics with art using different mediums. Presently we are using patchwork and quilting techniques to reproduce mathematical ideas. The present work explores recursions.

Sierpinski's Triangle Revisited • The mathematical model underlying this work is called Sierpinski's Triangle, after the Polish mathematician Waclaw Sierpinski who described some of its interesting properties in 1916. Among these is its fractal or recursive character. Sierpinski's Triangle has been used by many artists. We recreate the triangle through patchwork, using floral designs which contrast with plain black fabric along the recursion. In one of the iterations we also use three repetitive plain colours which contrast with the free floral designs of the other iterations. Finally the triangle is freed from its rigidity through appliqué stretching throughout the whole work.

FERGUS RAY MURRAY

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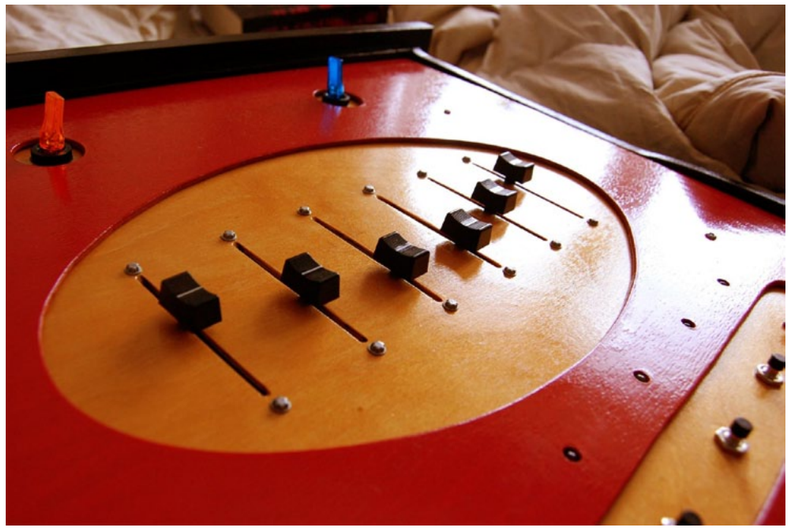
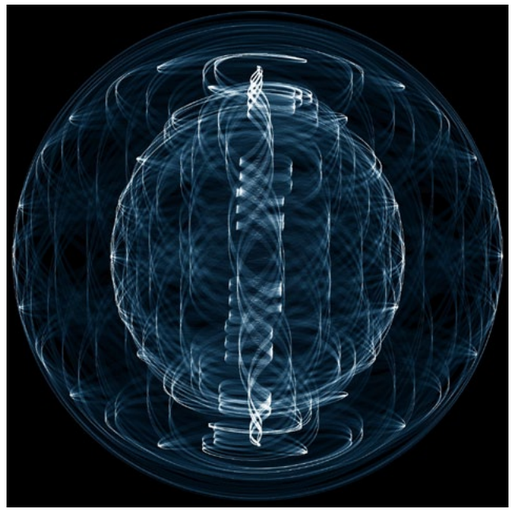


Kenneth and the Waves
19" x 17" x 6"
Interactive computer animation with wooden/mixed-media control box

I have been creating mathematical graphics since I first learned to program on a ZX Spectrum, and animating them ever since computers have been up to the task. My language of choice these days is Processing. Most of my animations and stills are based on trigonometric functions and waves.

Kenneth and the Waves • TA collection of interactive animations based on interacting waves and sinusoidal functions. A control box featuring six sliders, five buttons and two switches allows the audience to control the visualisations. One pair of sliders controls amplitude; one controls wavelength; one controls speed. The buttons switch between the different animations, while the switches control features of the visualisation. The animations will appear on a screen, or projected on a wall. Sinusoidia shows two sine waves, the difference between them, and their superposition. Zoobie is a membrane of glowing points, distorted by two waves passing through at right-angles to each other. Trochor is based on a rotary harmonograph - the line traced out by the sum of the motion of two damped pendulums swinging in circles. Rosaly adds another pendulum, and removes the damping. Yinyo shows the superposition of two gradated spirals as they spin.



Vortical
18" x 18"
Digital print on canvas

Vortical • Complex curves on a supertoroid; or, if you like, glowing traces as we circle around a rotating torus. x=majorRadius*cos(roundward)*(1-cos (holeward)));
y=majorRadius*cos(dunkward)*sin(holeward)+minorRadius*sin(roundward)*sin(dunkward)*(1-cos(holeward)));

DANIELA RINAUDO

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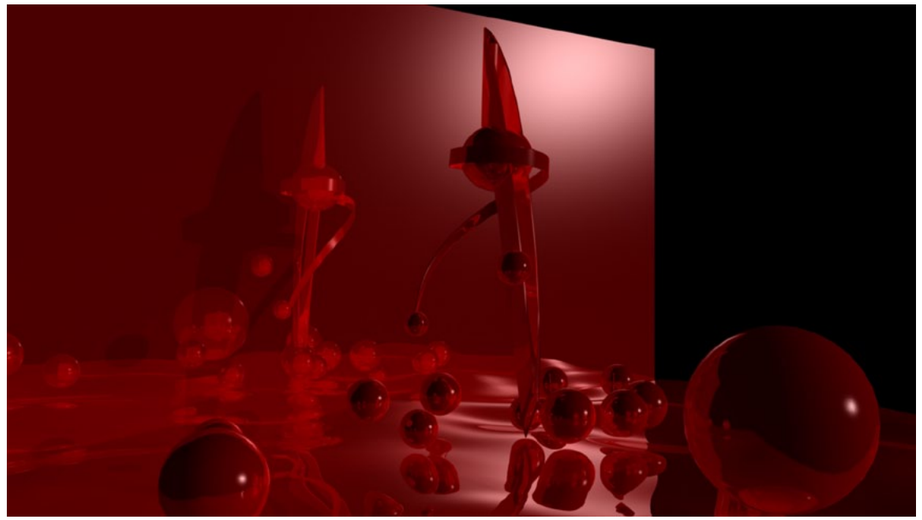

Geometric Man
1920 x 1080
Video.

I create Mathematical Art because I think it is very interesting to be able to make visible abstract ideas.

Starting from Platonic theory of ideas, according to which the real essence of this imperfect world is the perfect Geometry, I like to create pure and essential shapes, where these shapes are nothing but the mental hidden landscape.

I am trying to experiment new methods to represent and then to simulate the geometric properties of the movement with computer graphics.

Geometric Man • Geometric Man is a virtual journey into the "imaginary Time", in search of another dimension into Space. His movement represents a conceptual abstraction of the "real Time". Time loses here its linearity, gaining cyclicality: it becomes a spiral. "Geometric Man" is meant to be a "shade", that is an abstraction. Denatured from his anthropomorphic forms, it becomes "Compass" and writes a story in the "actual Time" which, in turn, leads to another story in the "imaginary Time" and vice versa. However, the two stories can be very different. By manipulating visual properties like reflections and refractions, we show in it how it is possible to create a fourth spatial dimension.

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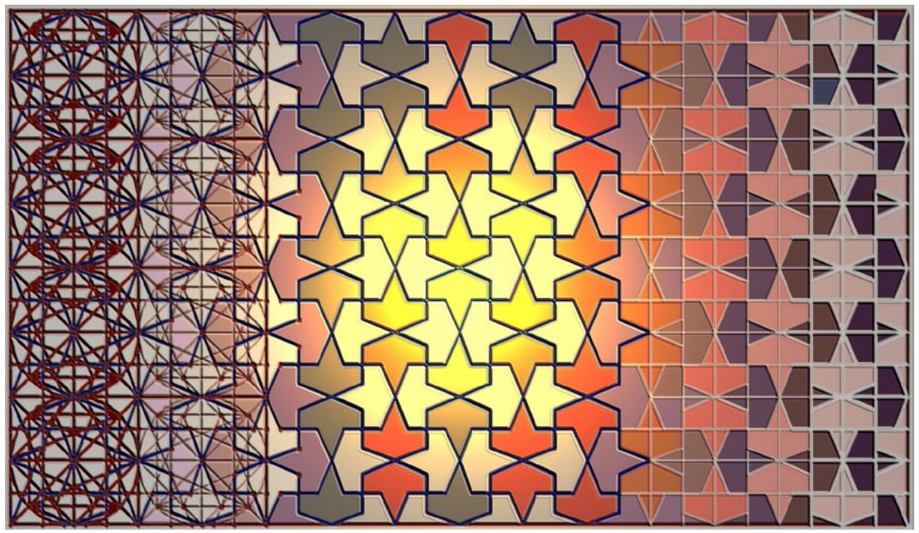


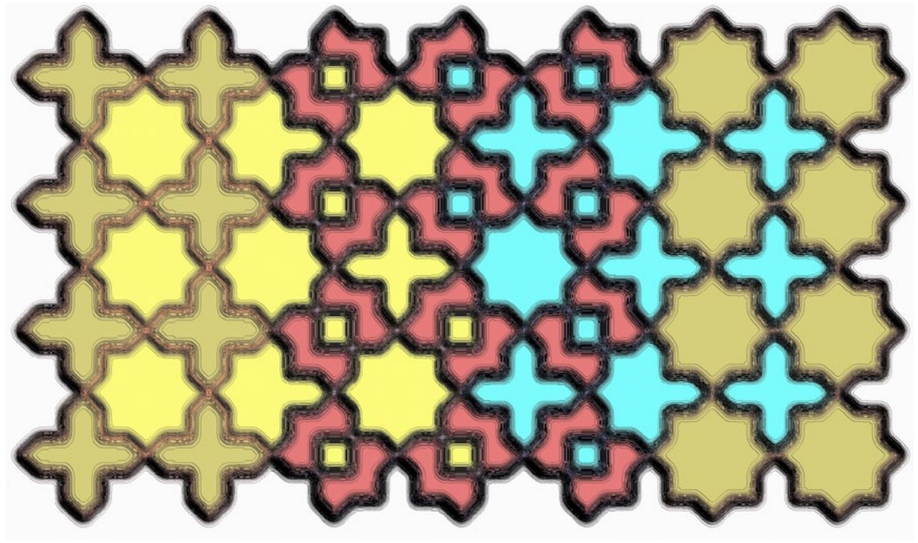
Kharragan I
16" X 20"
Digital print

I am interested in Persian geometric art and its historical methods of construction, which I explore using the computer software Geometer's Sketchpad. I then create digital artworks from these geometric constructions primarily using the computer software PaintShopPro.

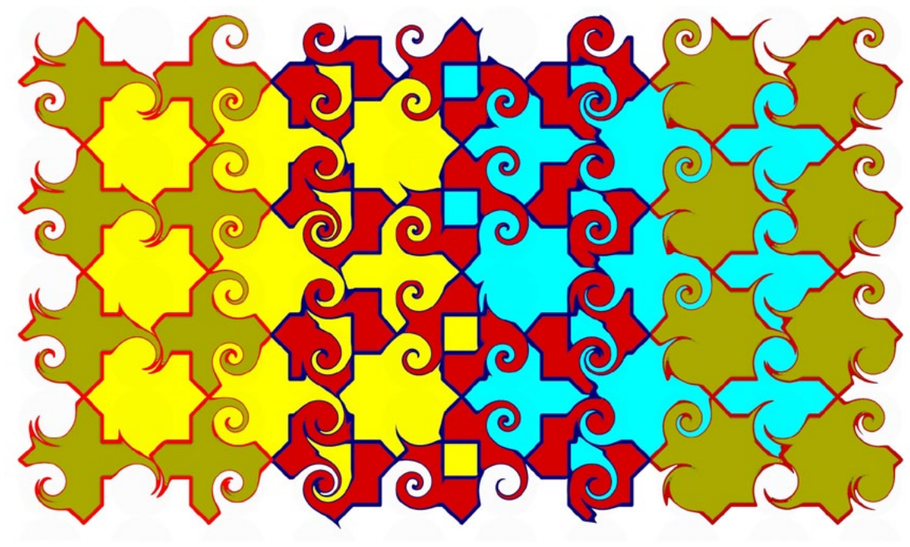
Kharragan I • Kharragan I (January 2011) is an artwork based on a design on one of the 11th century twin tomb towers in Kharraqan, western Iran. The artwork demonstrates two different approaches that are assumed to have been utilized centuries ago to create the layout of the pattern, which is at the center of the artwork. From left to right, the artwork exhibits the construction of the design based on a compass and straightedge. From right to left, we see another approach, the Modularity method, to construct the same design using cutting and pasting of tiles in two colors. These two methods of constructions were presented at "A Workshop in Geometric Constructions of Mosaic Designs" during the 2010 Bridges Conference, Pécs, Hungary.

Metaphor II • Metaphor II (December 2008) is a metamorphosis made from two different patterns: Cross–Octagram pattern, and Butterfly pattern. The far sides to the left and to the right of the artwork present the Cross–Octagram pattern but in opposite orders. The transition from left to right is achieved by some butterfly shaped elements. The blank space between four octagrams is a cross, and the four crosses make an octagram. So in some sense, we may say that the cross and the octagram are each other's duals. An interesting observation about the butterfly shaped element is that the space between four of them could be either a cross or octagram, depending on their arrangements. Because of this property, the transition from Cross–Octagram to itself but in an opposite order is possible.

Metaphor III • In Metaphor III (December 2008) we see the same metamorphosis as Metaphor II but in a new way, where spirals are introduced to eliminate rigid lines and present a new harmony and balance.



Metaphor II
16" X 20"
Digital Print



Metaphor III
16" X 20"
Digital Print

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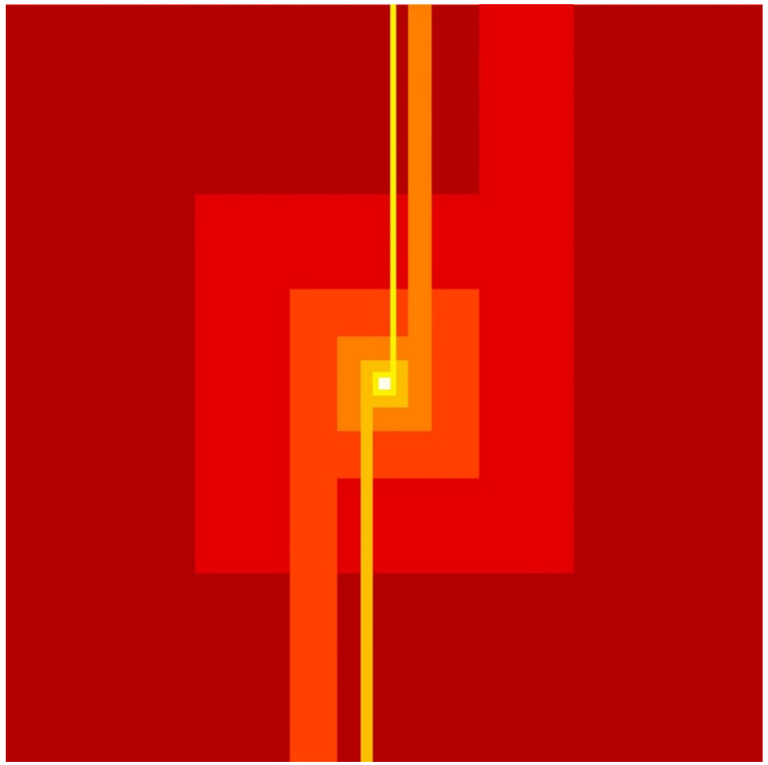
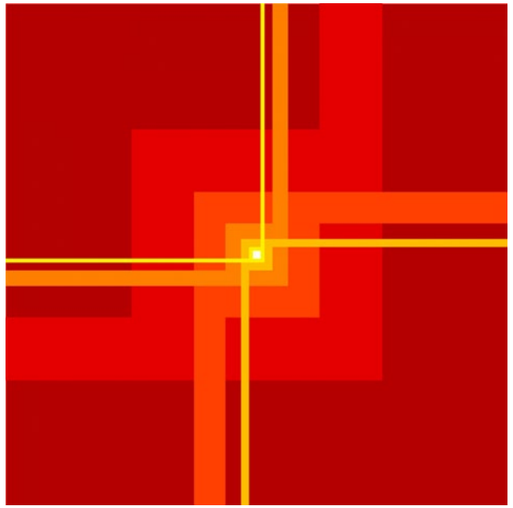


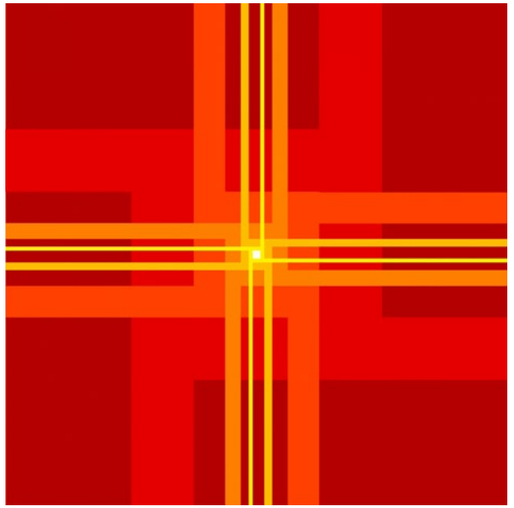
The Seventh triptichon 1
100x100 cm
oil on canvas

The idea of immaterialisation I could only model in painting by using such elements as even in themselves represent the supremacy of pure sensation. Thus two basic suprematist elements, the square and the cross through which the square is divided into four parts, have served as points of departure. In this case, the square bears a yellow colour symbolising existence, whereas its opposite, the cross is characterised by a white tone that creates an impression of emptiness. During the construction of the picture, i.e. the deconstruction of the yellow square, I came to set up a polydimensional net. The net that connects micro- and macro-worlds, stretched in infinite dimension structures as a hyper-filter, incessantly attempts to jettison the imperfect objects (yellow squares) of existence from its 'body'.

The Seventh triptichon 1 • The Seventh 1991 (triptichon, oil on canvas, 100x100 cm each) The basis of this triptichon is a sequence of nested squares. These squares compose a well designed proportional system both in geometric and chromatic sense. Geometrically the edge of each nested square is the half of its framing square (a, 2a, 4a, 8a, 16a, 32a, 64a, i.e., 2(n-1)a) and, consequently, the areas of the consecutive framing surfaces form the sequence: (a2, 3a2, 12a2, 48a2, 192a2, 768a2, 3072a2, i.e., if n>1: [22(n-1)-22(n-2)]a2). The colour signatures assigned to each of the squares form a mathematical sequence, similar to the edge lengths, from a saturated claret outside to white inside. The individual units of the triptichon display proportional width stems starting from the sides of the inner squares...



The Seventh triptichon 2
100x100 cm
oil on canvas



The Seventh triptichon 3
100x100 cm
oil on canvas

The Seventh triptichon 2 • The Seventh 1991 (triptichon, oil on canvas, 100x100 cm each) ...There are two stems running down and three stems running up in the first unit. They originate from the 3rd and 5th squares (numbered from inside), and from the 2nd, 4th and 6th respectively. This means, one from each square, alternately up and down, with the exception of the central and, naturally, the outer squares. The stems keep the colour and the width of the nested frame of the squares they originate from. Thus, they display the width proportions whose scale was fixed by the lengths of the nested squares' edges. Note the harmony, that the brightness of the lines originating from the inner squares optically balances their more narrow width. The second unit of the triptichon extends the stem system developed for the first unit. The stems are reflected to the main diagonal of the square system, keeping the original stems too...

The Seventh triptichon 3 • The Seventh 1991 (triptichon, oil on canvas, 100x100 cm each) ...Thus the image becomes mirror-symmetric in respect of this diagonal axis. The stems that run down in the first unit, now run also to the right, and the stems running up in the first unit now run also to the left. The third unit of the triptichon is a further extension of the first two. It is obtained from the second unit by a four-fold rotation of its right up quarter around the center of the squares. All the five stems run in all the four perpendicular directions. At the first unit they all run out of the inner squares at those right sides, now the choice of the right up quarter to be rotated gives a balance to the image by stems running alternating from the right and left sides of the inner squares. While the second unit is mirror symmetric, this third unit displays a four-fold rotational symmetry. (György Darvas, 4 March 2011)

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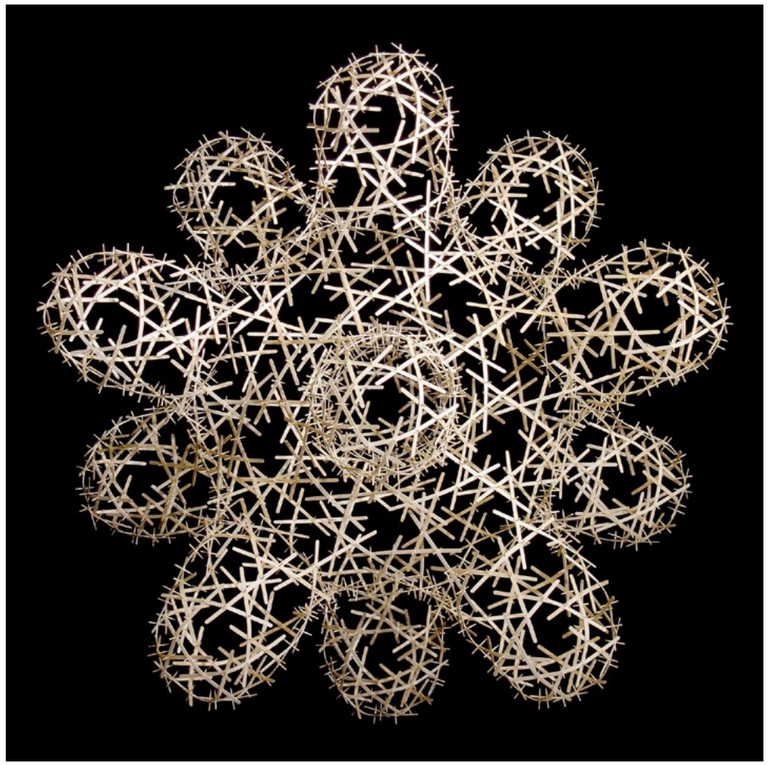

Hyperbolic Coffee Cactus
14" x 14"
Photograph

I make polyhedral sculptures, lighting and shelters from recycled, reused and repurposed materials. My work explores the beauty of maths and the creative possibilities of recycling.

Unlike much mathematical art that is purely abstract, I use recognisable household objects to make work that is accessible, real and fun. I hope by extension to make maths and geometry tangible to a lay audience.

My largest work to date is Show Home, a 4-metre geodesic shelter made from 135 estate agent signs. I've also made smaller versions: To Live (a 2.4m pod) and To Play (a 1.2m playhouse).

I'm currently working on the design for a hyperbolic shelter to be built with over 1,000 metre rulers. I hope to find a school to commission it for their outdoor space.

I've been inspired mathematically by Magnus Wenninger, Stewart Coffin and Buckminster Fuller; and artistically by land artists Andy Goldsworthy, Richard Long and Jan Dibbets.

Hyperbolic Coffee Cactus • 1.2-metre bulging dodecahedral "cactus" woven from 630 wooden coffee stirrers, pinned together with 1,260 cocktail sticks. The underlying pentagon-hexagon-heptagon pattern forms distinctive "monkey saddle" hyperbolic surfaces all around.

Show Home
14" x 14"
Photograph

Sphere of Shadows
14" x 14"
Photograph

Show Home • 4 metre diameter, 3 metre high geodesic shelter built from 135 estate agent (realtor) For Sale and To Let boards. The outer shell is bolted together with the plastic bolts normally used to erect signs. It is reinforced inside by an icosahedral framework of 25 wooden signposts. The piece makes a statement about homelessness, the housing market and sustainable architecture.

Sphere of Shadows • 1.5-metre sphere of 120 individual schoolchildren's silhouettes, made as a public art commission for Stourfield School in Bournemouth, UK. The pieces were machine-cut from recycled plastic board and bolted together. The artwork acts both as a static sculpture for the school's Outdoor Classroom, and as a play ball that children can roll around and get inside.

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Body-Index-Cloth I
83 x 50 x 30 cm
Fashion, 100% Cotton with Satin ribbon

Body-Index-Cloth II
83 x 50 x 30 cm
Fashion, 100% Cotton with Satin ribbon

Body-Index-Cloth III
83 x 50 x 30 cm
Fashion, 100% Cotton with Satin ribbon

As an artist and designer, studying at the University of applied Arts, dealing with mathematics is a possibility of expanding my workfield to inspire myself with new methods. By the fusion of mathematics and fashion, a further medium is generated. It shapes and defines body in a new context and opens up a variety of exciting design processes.

Body-Index-Cloth I • This fashion piece consists of four parabolas, corresponding to the individual body wearing it. The parabolas are not changed, there are no tucks nor pleats and no additions of garment, just plain parabola-forms. They are sewed together in a certain order and arrangement. The aim is to design a mathematically formed piece of cloth, only by using the individual parabolas. As regard to certain reference points, the parabolas refer to the person by including body height and body weight in their formula. These parabolas transform the parameters "appearance" and "weight" of the individual body into a geometrical model. By finding another visually, logically and mathematically understandable system, the relation between body and cloth is enforced. By specific and varying combinations, these parabolas start to form and define the body - by simultaneously relating to it.

Body-Index-Cloth II • This piece of cloth follows the same conditions as the one to the left.

Body-Index-Cloth III • This piece of cloth follows the same conditions as the two to the left.

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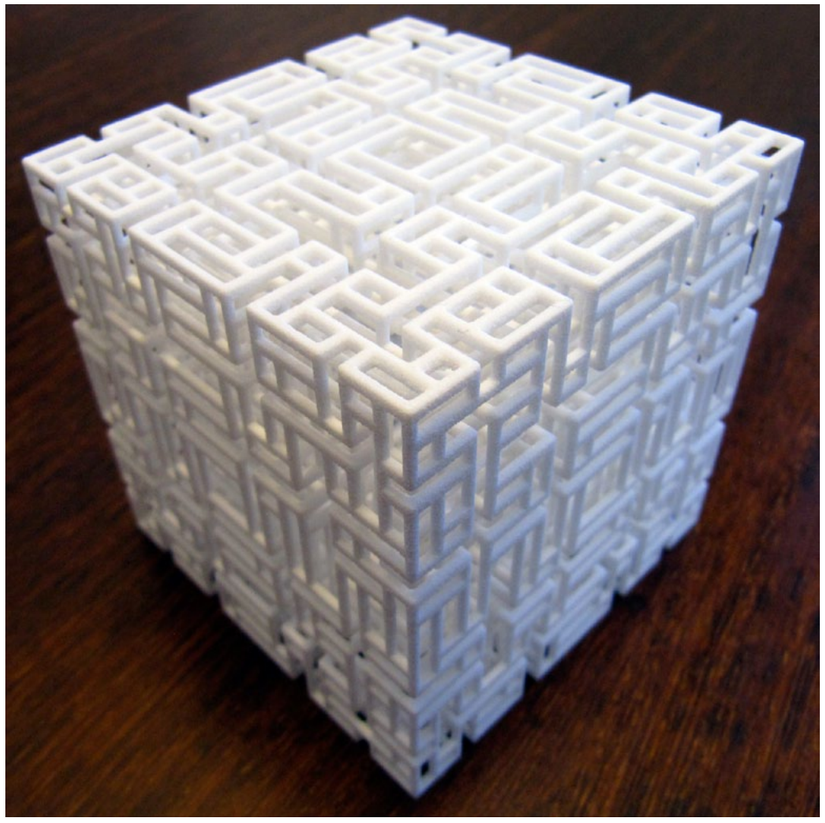
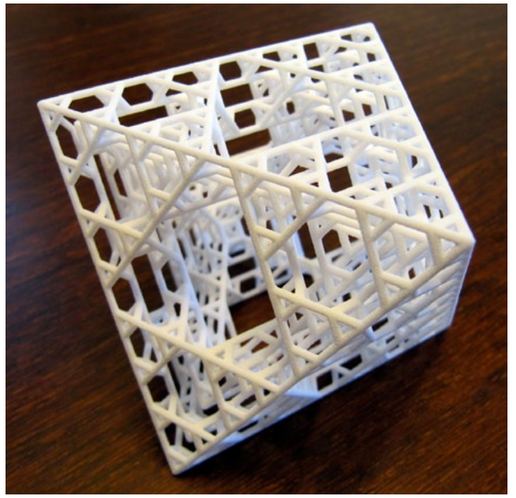


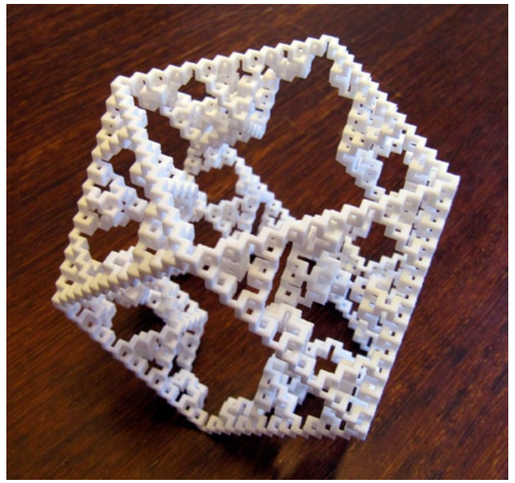
Space filling graph 1
68 x 68 x 68 mm
PA 2200 Plastic, Selective-Laser-Sintered

Henry Segerman is a postdoctoral mathematician. His mathematical research is in 3 dimensional geometry and topology, and concepts from those areas often appear in his work. Other artistic interests involve procedural generation, self reference, ambigrams and puzzles.

Space filling graph 1 • This is a graph embedded in 3-dimensional space as a subset of the cubic lattice. The graph has a fractal structure, analogous to the fractal structure of a step in the construction of a space filling curve, but with greater connectivity. This greater connectivity makes the physical sculpture considerably more robust than the analogous sculpture of a step in the construction of a space filling curve would be. Each vertex at each step of the construction is degree 3, and is replaced at the next step by 8 vertices arranged in a 2 x 2 x 2 cube, with certain choices of edges connecting them to each other. Each edge is replaced at the next step by 4 parallel edges. We begin the construction with the first step being the edges of a cube, and this is the result at the fourth step. The spacing between the vertices varies in order to highlight the fractal structure.



Octahedron fractal graph
103 x 103 x 103 mm
PA 2200 Plastic, Selective-Laser-Sintered



Cuboctahedral fractal graph
66 x 66 x 66 mm
PA 2200 Plastic, Selective-Laser-Sintered

Octahedron fractal graph • This is a graph embedded in 3-dimensional space as a subset of an "octahedral lattice", which is related to the tessellation of space using octahedra and tetrahedra. The graph has a fractal structure, formed by a process of repeated substitution. Each vertex at each step of the construction is degree 4, and is replaced at the next step by 6 vertices arranged in an octahedron, with certain choices of edges connecting them to each other. Each edge is replaced at the next step by 2 parallel edges. We begin the construction with the first step being the edges of an octahedron, and this is the result at the fourth step.

Cuboctahedral fractal graph • This is a graph embedded in 3-dimensional space as a subset of the cubic lattice. The graph has a fractal structure, formed by a process of repeated substitution. Each vertex at each step of the construction is degree 3, and is replaced at the next step by 7 vertices which can be thought of as a subset of a 3 x 3 x 3 cube, with certain choices of edges connecting them to each other. Each edge is replaced at the next step by a single edge, joining to the vertex in the centre of each 3 x 3 face. We begin the construction with the first step being the edges of a cube, and this is the result at the fourth step.

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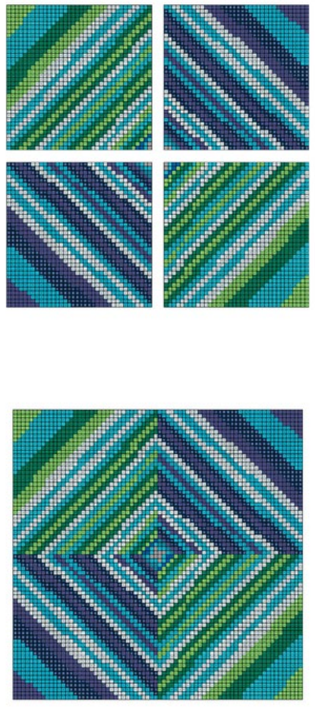
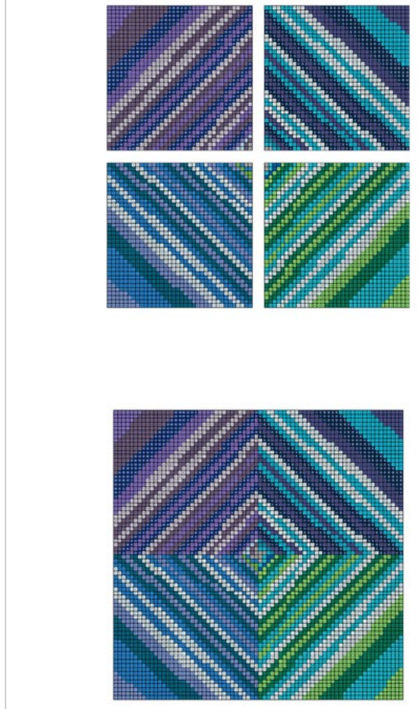


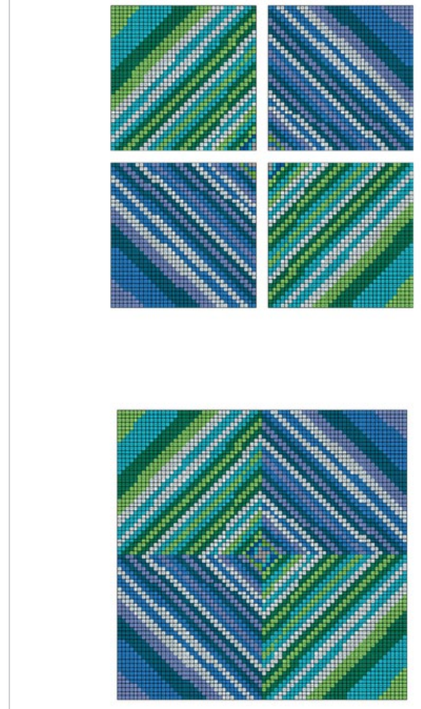
Prime Squares #1 Disjoined and Conjoined
20" x 36"
Print

I am not a mathematician. I majored in history and journalism. My highest math class was not calculus, it was math for liberal arts major, or as my transcript says "Concepts of Fundamental Math" (lovingly nicknamed 'fun-for-mentals' by the mathematics department). I didn't even begin my life as an artist until 8-hour graduate school seminars and a set of highlighters gave me time and opportunity. Art was a way I could multi-task and make my lecture notes look like Seurat's pointillist landscapes. As it turns out, I love math and I love art, and I love creating art that also uses math. I am fascinated by shapes, patterns, design, and colors. For the past few months I've been exploring prime numbers and the patterns they can make both on a grid and in more organic free-forms of drawing. I think numbers are beautiful and complex.

Prime Squares #1-#3 Disjoined and Conjoined · In my explorations of the patterns of prime numbers, I tried many different configurations using grid paper. I began to spiral the numbers out from the center of a grid. I filled in numbers from right to left. Finally, I began filling in the grid along the diagonal and it created an attractive and much more interesting pattern than my earlier grids. Every prime number in sequence is represented by its equivalent number of squares on the grid. Additionally, each square is numbered, providing another layer of meaning and texture to the artwork. Color captivates me; I was trying to come up with a pattern using 6 colors that corresponded to the 6 different ending digits of all prime numbers (1, 2, 3, 5, 7, and 9). For example, the prime number '51' is represented by the same color as all other primes ending in '1' (11, 31, etc). I tried hundreds of color patterns, eventually settling on four bold color palates.



Prime Squares #2 Disjoined and Conjoined
20" x 36"
Print



Prime Squares #3 Disjoined and Conjoined
20" x 36"
Print

NATHAN SELIKOFF

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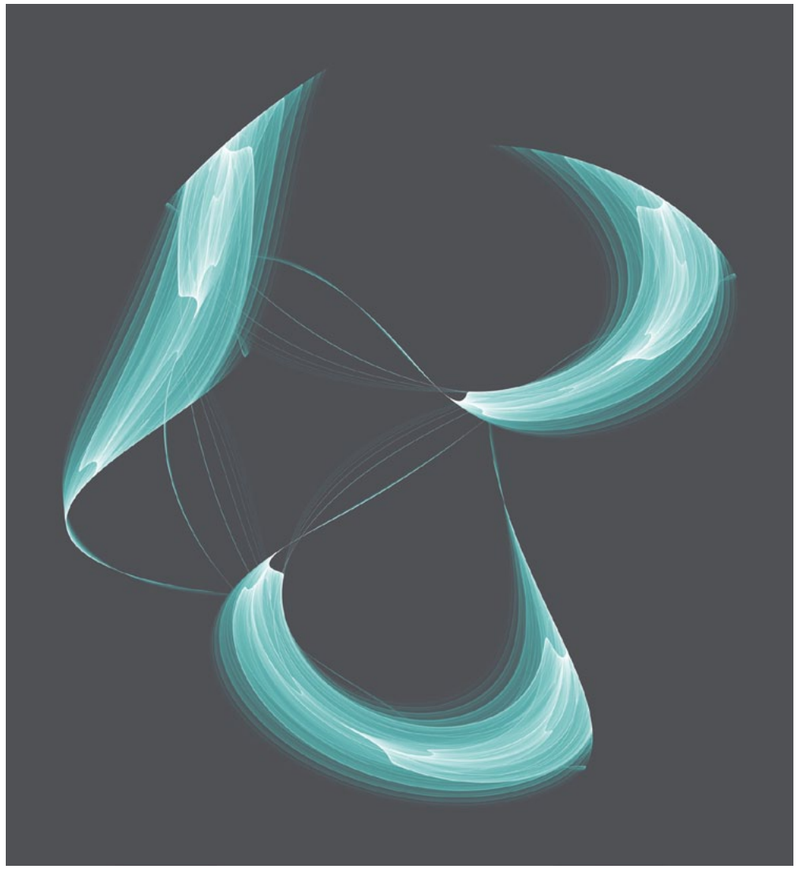


Trefoil
14.15" x 13"
Print

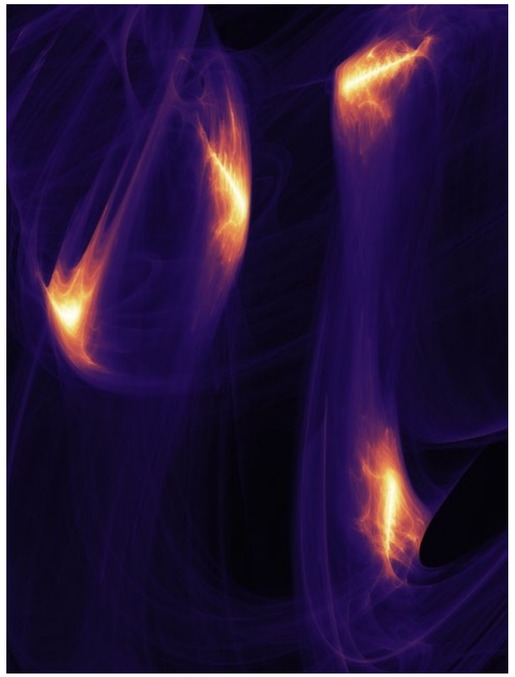
I love to experiment in the fuzzy overlap between art, mathematics, and programming. The computer is my canvas, and this is algorithmic artwork—a partnership mediated not by the brush or pencil but by the shared language of software. Seeking to extract and visualize the beauty that I glimpse beneath the surface of equations and systems, I create custom interactive programs and use them to explore algorithms, and ultimately to generate artwork.

In the world of chaotic dynamical systems, minute changes in initial conditions produce radically different results. The interface of my software gives me hooks into the algorithms and allows me to exert a measure of control.

Art and mathematics, the right brain and the left, are inextricably linked in this work. My art depends on mathematics, yet simultaneously illuminates and unravels its beauty. I am the explorer who uncovers something extraordinary, bringing into view that which was always there to be discovered.

Trefoil • Have you ever seen a pendulum swinging over a pit of sand, tracing patterns as it moves? The results can be simple or complex, depending on the forces generating the motion. In a truly chaotic system, a strange attractor represents this final state, and can be visualized using surprisingly simple mathematical equations. Initially inspired by Clifford Pickover's Chaos in Wonderland, I have been experimenting with chaotic attractors since 2001. I call this series Aesthetic Explorations of Attractor Space.

Alluvial Fan II
15.75" x 13"
Print



Sprites
17" x 13"
Print

Alluvial Fan II • Part of what inspires me about this form is its resemblance to aerial photographs of river deltas and other geological phenomena. Perhaps it is a minimalistic interpretation of what this alluvial fan in the French Pyrenees looks like from above: http://en.wikipedia.org/wiki/File:Alluvial_fan_01.JPG

Sprites • I found these intriguing lightning creatures hidden in the infinite possibilities of strange attractor space. It turns out there is an electrical phenomenon that happens high above thunderclouds, called a sprite. Here's a real-world sprite imaged at 1,000 frames per second: http://www.youtube.com/watch?v=FmOCe5se9hk

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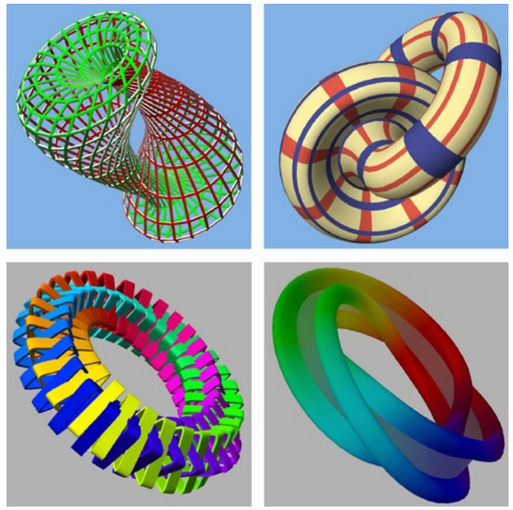
Internally Knotted Figure-8 Torus
8" x 6" x 6"
3D Model made on an FDM machine, ABS plastic



The World of Wild and Wonderful Tori
24" by 24"
Composite of computer images

I work on the boundary between Art and Mathematics. Sometimes I create artwork by using mathematical procedures; at other times I enhance a mathematical visualization model to the point where it becomes a piece of art. For the art exhibit at Bridges 2011 my submissions support my plenary talk: "Tori-Story." My presentation elaborates on the classification of all topological tori into four regular homotopy classes, where the members in one class cannot be smoothly transformed into members of another class. My art submissions depict some intriguing structures that topologically are torus surfaces, but with enough surprising contortions so that ordinary people would not immediately see them as your every-day donut.

Internally Knotted Figure-8 Torus • This torus can be described as an ellipsoid with a Figure-8-knot tunnel through it.

The World of Wild and Wonderful Tori • Four panels of four different tori models: Panel A: Half-Everted Torus: Two Klein-bottle mouths joined in a symmetrical manner into a toroidal configuration. Panel B: Collared Torus: A toroid with a cusp onto which another toroid has been grafted with its parameterization turned by 90 degrees. Panel C: Doubly-Looped Torus: A 3-fold epitrochoid profile swept twice around a circular path while applying a total twist of 360 degrees. Panel D: Doubly-Rolled Torus: A curtate hypocycloid profile swept once around a circular path. The challenge now is to figure out for each of these tori into which regular homotopy class they belong.

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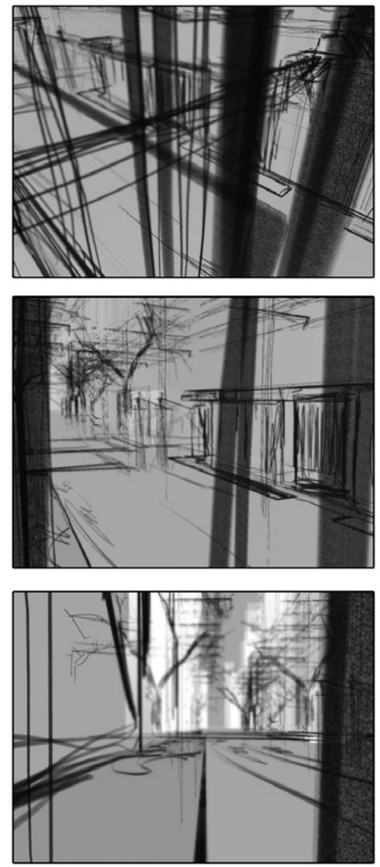

Animated LInes
10.5 x 21.5
Charcoal and pencil on 3D Digital Print on Canvas

Animated Lines is a digital hand drawn using charcoal and pencil in a 3-dimensional space using one point perspective. The strokes are carefully choreographed by constructing and de-constructing by utilizing the digital 3D surface and traditional hand drawing techniques. As an artist, I am interested in bridging the boundaries on subject of argumentation, conflict and dialogue over territory, history and identity. These images are mathematical representation of chaos theory; an attempt to investigate the mental process in a symbolic direction of art making practice.

Animated LInes • Animated Lines is a digital hand drawn using charcoal and pencil in a 3-dimensional space using one point perspective. The strokes are carefully choreographed by constructing and de-constructing by utilizing the digital 3D surface and traditional hand drawing techniques. As an artist, I am interested in bridging the boundaries on subject of argumentation, conflict and dialogue over territory, history and identity. These images are mathematical representation of chaos theory; an attempt to investigate the mental process in a symbolic direction of art making practices.

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Bracelet of Fluffies
7 1/12" x 2"
Beadwork--Swarovski (r) crystal beads and monofilament and sterling silver clasp.

Laura Shea loves creating complex polyhedral structures from beads and thread. Her work explores classic geometric forms-whole and partial frame polyhedra, regular tilings and tessellations. She connects the component forms at contiguous polygonal faces to create chains and complex polyhedral structures. The open networks of tilings and frame polyhedra provide a magical space for light to play with glass.

Bracelet of Fluffies • Surface decorated truncated icosahedrons in various shades of red and pink.

Glimmeris • Truncated icosahedron supporting 12 double stacks of dodecahedrons.

Bubbles • Great Rhombicosadodecahedron with half dodecahedra forming 'bubbles' at each decagonal opening.

Glimmeris
3" x 3"
Beadwork--Swarovski (r) crystal beads and monofilament

Bubbles
3" x 3"
Beadwork--Swarovski (r) crystal beads and monofilament.

BOB SIDENBERG

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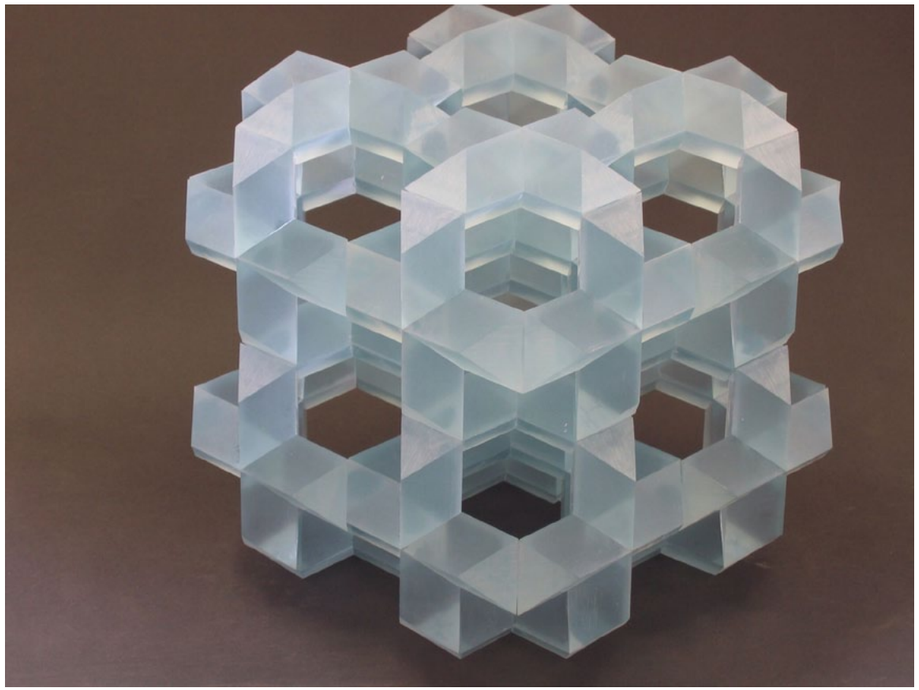
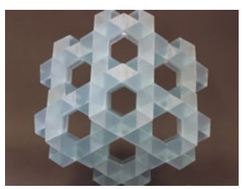
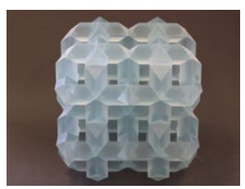


Blue Lattice
9" x 9" x 9"
cast polyester resin





Alternate views

I marvel at the geometry of the natural world, forms sublime and in transition, simple ones and tricky, elusive patterns and interlocking relationships. The Bridges Conference at Pecs inspired me to continue my exploration of lattices that intertwine and fill space. I've divided some earlier shapes into smaller, identical parts that seem like three dimensional fractals. My journey begins at the center of the cube, in the ether, in the spirit, where it can't be divided any more, at least not by us mortals.

Blue Lattice • I am trying to discover what causes the point at the center of the cube to race for the corners and what causes it to change direction. What did Maraldi know?

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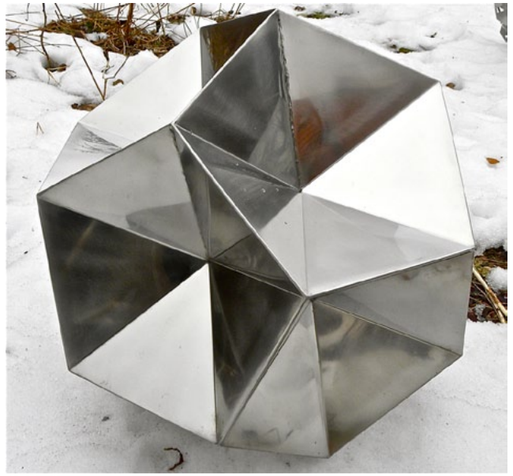

Dodecahedron Concave
18" x 18" x 18" (45 x 45 x 45 cm)
Stainless steel

Long Legged Circumciser
Approximately 19" x 19" x 19"
Stainless steel

From my very childhood I've been fascinated of patterns and structures, and from early off I tried to detect how different things were constructed.

In 3rd grade I discovered Geometry and The Golden Section and it became the sky rocket of my life. Soon I fancied myself to be an abstract artist — at the age of ten.

But the Jante Law soon got me down on earth. Nobody in my surroundings found any value in such childish plays. I was plain stupid, and they succeeded in making me believe it.

Nevertheless I've always continued to work with 'concrete things' and always had a love for geometry and mathematic (on a very low level). But because I was stupid, I really believed that, it was no idea to study such things on a higher level, which I deeply regret to day.

Still I have my fun. I love making impossible constructions or finding new ways of using geometry.

Dodecahedron Concave • Dodecahedron created of 12 hexagons folded and turned into concave pentangons by removing one sixth of each hexagon.

Long Legged Circumciser • Globe made by combining extented pentagrams. Three legged figures show in between.

SPENCER SMITH

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Torus Kingdoms
Print: 9" X 12", Frame: 15.25" X 19.25"
Linocut Relief Print; Oil based relief ink; Japanese paper; Proofing press

Topology came first
Egg: 2.25" X 1.75" X 1.75"
Dyed Egg (Ukranian Pysanky Style)

In general, aesthetic beauty is a notoriously hard notion to define and certainly depends a lot on subjective tastes. However, there are certain attributes which do seem to be common, underlying themes in universal ideas of beauty. Some of these attributes include symmetry, simplicity, and tension between order and disorder. As a physicist, much of what I intuitively see as beautiful in nature can be traced to the occurrence of these properties in the mathematics of our models of reality; symmetries in the quantum field theory Lagrangians of particle physics, simplicity in the least action principles of classical physics, and the tension between order and disorder in statistical mechanics phase transitions. As an artist, I try to illustrate these ideas through the direct visual impact of the work as well as through the mathematical subject matter. On a lighter note, playing around with math, physics, and art is just plain fun!

Torus Kingdoms • The outer region has a traditional Islamic tessellation of the plane, while the inner region consists of seven Japanese inspired patterns. This inner region can be considered the fundamental domain of the universal cover of the torus, i.e. you can connect the top edge to the bottom and then the left edge to the right to form the surface of a doughnut. On the torus the seven patterns, or colors, form contiguous regions, each of which touch every other color. On the plane, such a partitioning of the space would need at most four colors to distinguish the regions. On a torus, seven colors are sufficient; indeed, I've illustrated a case where all seven colors are needed.

Topology came first • The coloration on this egg was produced by dyeing with successively darker dyes and blocking off areas with bees wax between applications. The surface is broken up into 48 red and black triangles, which are formed from the intersection of 8 great circles (if this were a sphere). The black triangles contain a trefoil knot (left-handed), which is the first non-trivial prime knot and the (2,3)-torus knot. The red triangles contain a link usually referred to as Borromean rings. They have the interesting property that cutting one loop will release the other two.

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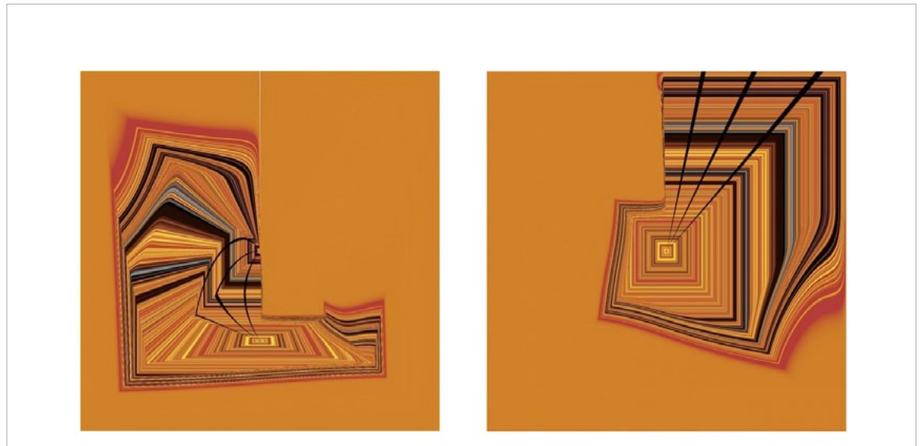
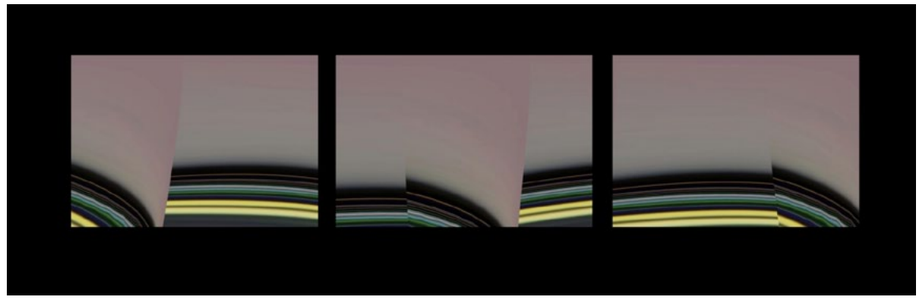


Heterotic String Theory no. 1, 2
two 10"x10"
digital print



The Mathematics of Rainbows part 1, 2, 3
TBD
digital print

A line can only be imagined in reality. It exists only as a concept in the mind. A line, by definition, is comprised as an infinite series of points in a row. A point has no length, width, or height. If a point has no dimension, can a line exist as an infinite number of points?

These images play on the feature scale and the blurriness of lines with which the detail and focus-level are controlled.

Heterotic String Theory no. 1, 2 • Heterotic string theory was created by folding a photograph using free and open source software. It was then polarized with error points to create the asymmetry or 'human factor'.

The Mathematics of Rainbows part 1, 2, 3 • The Mathematics of Rainbows was created using free and open source software. A solid square containing the colours of a rainbow was broken down and re-assembled with manual error points to fragment the piece. This provides a non-linear 'organized randomness' to the piece.

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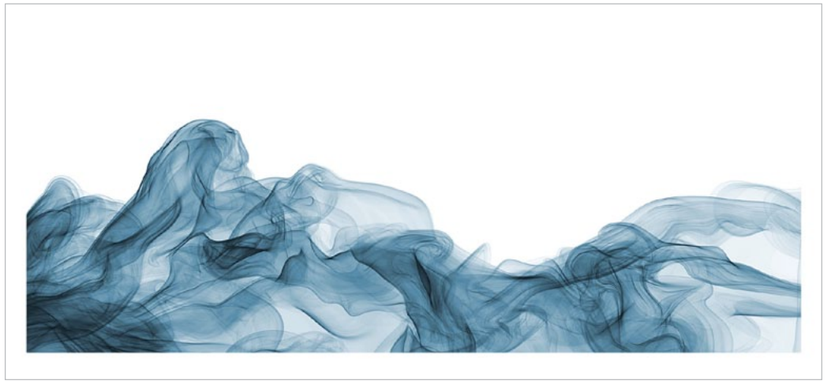
Magma 19
24" x 20"
Archival inkjet print

All of my work depicts imaginary scenes that derive their complexity from the deceptively simple behavior of large numbers of independent actors/agents/particles/elements. The rules governing the action of each element are often based on primary natural and physical forces and can be described in a single mathematical statement or a few lines of code. Alone, each element emits a trivial and boring solution, like a single star floating motionless in space. Together, though, these elements create massively-complex galaxies of shapes and forms inspired by, and reflecting, the natural origin of their rules. This is the way of computational science: to break complex, real problems up into many smaller and easily solvable problems such that the ensemble predicts the behavior of the real system. That was my education, and it is now the source of my artwork.

Magma 19 • Meant to evoke the deep, hot underbelly of the Earth, "Magma 19" depicts a virtual flow of red-hot molten magma and nearby cooler rock. The immense detail in the plumes, ebbs, and eddies create many tiny fluid landscapes across the entire piece. The image was created using a two-dimensional computational fluid dynamics algorithm, which evolves the initial form according to the vorticity transport equation. Because this simulation is based on physics, familiar shapes and patterns emerge in the system as warmer media rises, boundaries become unstable, vortices dissipate, and emergent structures exchange energy.

Wave For Hokusai • This work is a tribute to the Japanese artist Katsushika Hokusai, whose woodblock print "The Great Wave off Kanagawa" (c. 1829-32) is not only one of the most-recognized pieces of Japanese art, but is also appreciated by turbulence researchers as an early representation of the "turbulent cascade" of energy from large to small scales. The work was created by tracking and simulating the motion of a vortex sheet in three dimensions using comptational physics algorithms. In the ensuing simulation, wave-like structures emerged at a variety of scales. Visualizing these wave forms without perspective or other depth cues accentuates the barrier between the real and the simulated.



Wave For Hokusai
16"x24" framed
Archival inkjet print on paper

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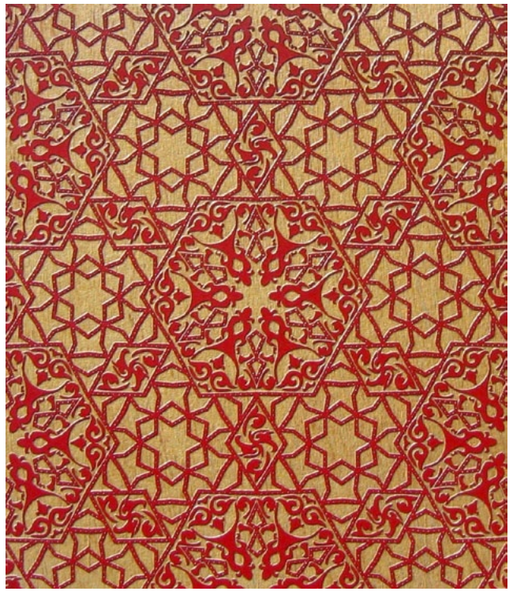

Reidun #4
300 x 300 mm
Painted and etched wood composite

Reidun #5
300 x 300 mm
Painted and etched hardboard

As a designer I am fascinated by the fundamental concept of symmetry and its varied interdisciplinary applications. This recent work explores the possibilities of patterns repeating in three-dimensions, around the faces of mathematical solids.

Reidun #4 • This piece was created through manipulation of the virology-inspired tiling used in the patterned rhombic triacontahedron Reidun #1, shown at the Bridges Art exhibit in Pécs 2010. Inspired by a novel approach to the description of viral capsid assembly proposed by Reidun Twarock, the faces of this rhombic triacontahedron are tessellated with kites, darts and rhombs. The Islamic-inspired design was developed from biological imagery, which is reminiscent of Islamic interlace patterns. The tiling has been manipulated in the plane to form a p6m repeating design.

Reidun #5 • This design was developed from biological imagery sourced during an investigation into virus structures. Inspired largely by the work of Reidun Twarock, who proposed a novel approach to virus capsid structure based on tiling theory, the tile originally formed a component of the patterned rhombic triacontahedron Reidun #4, and has been manipulated to form a p6m tessellation.

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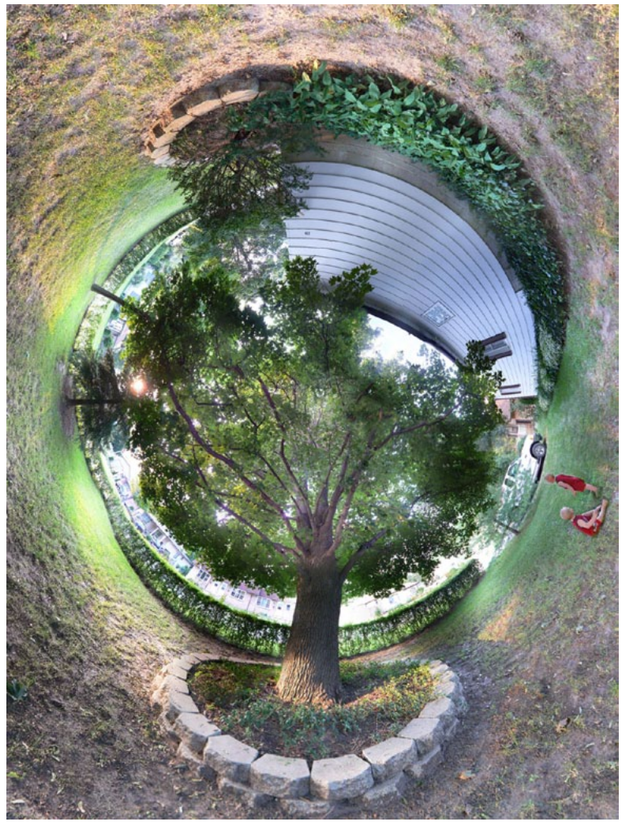


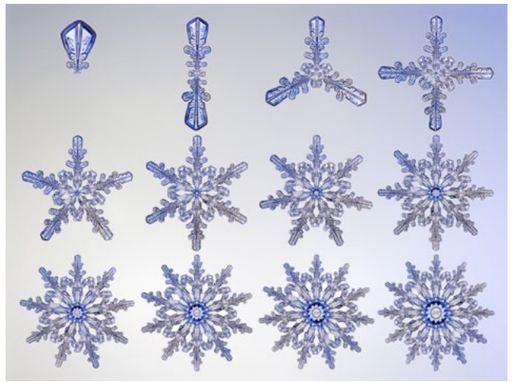
I Think That I Shall Never See...
24" x 18"
Digital print on canvas

I am a visual artist / photographer that creates mathematical artwork. I prefer to "grow my own" software which allows me the flexibility to explore or enhance new and existing mathematical ideas.

My goal is to create visual puzzles that demonstrate the fascinating aspects of themes that interest me — including but not limited to reflections, spherical geometry, image transformations, and spherical panoramas.

When someone sees my work, I hope their first reaction is that they feel the piece looks nice, followed closely by, "hey, what's going on?" and ideally followed up with either a new understanding, or more questions about the mathematics and the ideas behind it.

I Think That I Shall Never See... • A stereographic projection of a spherical panorama centered on the zenith point: If we think of the visible sphere as a translucent sphere around the observer's head with imagery printed on it that matches the observer's surroundings: then this is what we would see on an imaginary ceiling if we were to shine a lamp from the sphere's lowest point. This composition takes advantage of the conformal properties of the stereographic projection: we see that each detail in the panorama remains undistorted (particularly the two boys).



Conformal Snowflakes
18" x 24"
digital print on canvas

Spherical TSP Art
Three spheres: 3" x 3" x 3" each
3D prints supported by plastic spheres.

Conformal Snowflakes • This is joint work with Pam Eveleigh. Her original photograph of a six pointed snowflake is transformed into eleven new versions with varying rotational symmetries. Conformal mappings are used here to avoid any stretching artifacts and consequently to avoid any evidence of "image tinkering". This exercise is done somewhat ironically and with some chagrin considering the plethora of improperly rendered non-six-pointed snowflakes in design and advertising. To anyone familiar with actual snow crystals, these new versions will seem "wrong". Alternatively one can consider these as attractive examples of what snowflakes would look like in a world where six pointed ice crystals were not the norm.

Spherical TSP Art • 2D TSP Art techniques are extended to the sphere. The "Yin-Yang circle packing method" presented by Michael Longuet-Higgins at Bridges 2010 was adapted to distribute the cities onto the sphere, and the final models were generated using custom software. The patterns chosen are two-tone patterns: the familiar soccerball pattern, the pattern depicting the icosahedral symmetry groups, and appropriately enough for a travelling saleman, the world.

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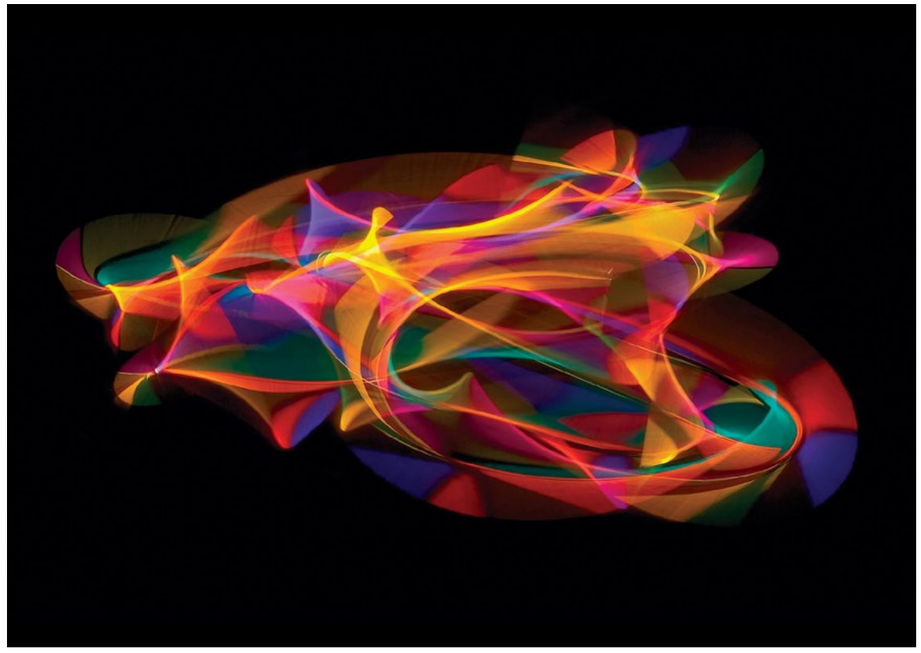


Light drawing with revolving slit colour pen
16.5 x 11.5 ins inkjet print
Inkjet print

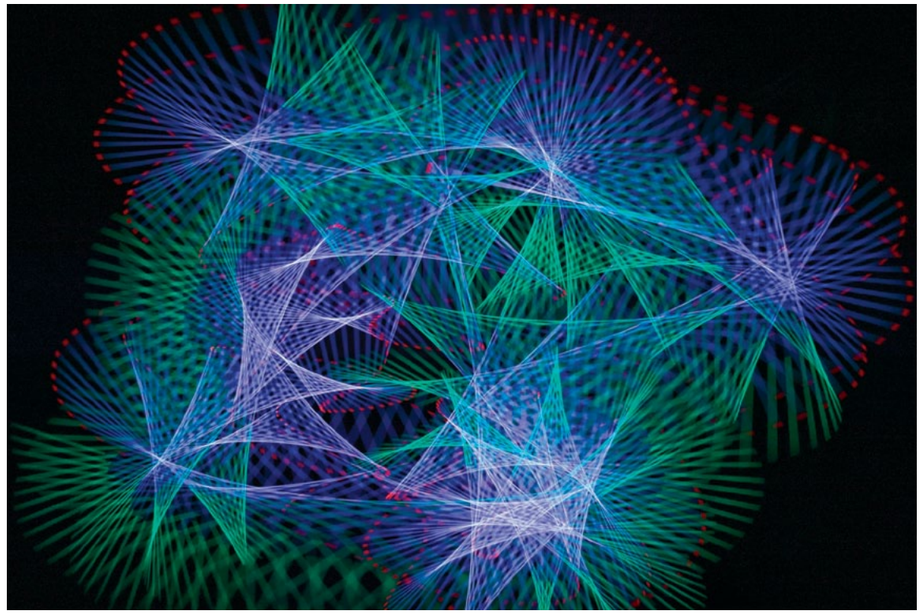
I work with programmable analogue drawing machines which I design, build and use to create art works. My machines are either integrally programmed or subject to external Timer control. There are four timers, the latest a fully programmable device, see website.

This work has recently been the subject of a successful PhD by practice at Manchester MIRIAD. Manchester Institute for Research in Art and Design. Mine was the first PhD to be completed there in this new form and I am the oldest student to submit. I have completed the amendments to my thesis and received the approval of my external supervisor. Currently having my theses bound. My preoccupation is with the potential of very simple instructions to create complexity and with art process.

Light drawing with revolving slit colour pen • Light drawing,with revolving slit colour pen, on Taitograph Turntable machine, programmed with Timer 1 recorded on digital camera and processed in Photoshop. PhD submission pic.

Light drawing with wide slit and shutter • Light drawing on Taitograph Turntable machine using shutter and wide slit light pen plus colour changer. Programed by Turntables integral programming system. PhD submission pic.

Neon single light source drawing • Light drawing on Taitograph NSEWch plotter rig fitted with digital camera on platen and top light colour changer unit which changes the pen colour as the drawing progresses. Programmed by Timer 4 latest fully programmable analogue timer control unit. PhD submission pic.



Light drawing with wide slit and shutter
16.5 x 11.5 ins inkjet print
Ink jet print

Neon single light source drawing
16.5 x 11.5 ins inkjet print
Ink jet print

OZAN TURKKAN

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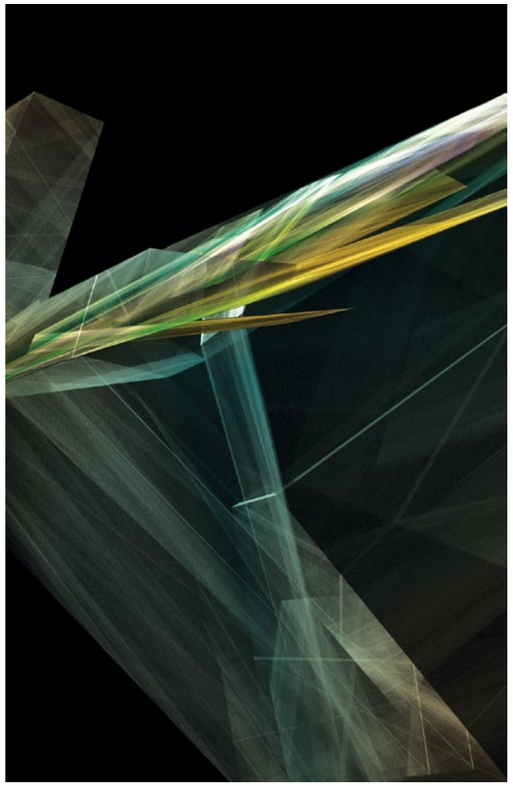
Silence of the Mind
600 x 600 mm
Digital Print on Paper

As a contemporary artist, I have general interest in experimental media and digital arts, and specific interest in complexity, generative computer art, algorithmic art and fractal geometry. I am using new computer tools that use algorithms in different programming languages to generate my art pieces.

I really enjoy to explore the many-folded boundaries between math and art in a creative process, to understand and reflect the universal nature and consciousness. Since mathematics is not just about formulas and logic, but about patterns, symmetry, structure, shape and beauty. I find there beauty of chaos and order together, and the balance between the masculine and feminine nature.

Silence of the Mind • Silence of the Mind is a generative artwork project which is developed using a generative grammar programming language, Context Free Grammar (CFG). And some additional image editing tools. Chaotic-looking image which represents fractal behavior of our mind, created by an algorithm (whihch is a well-ordered collection of unambiguous and effectively computable operations that when executed produces a result and halts in a finite amount of time) using a generative grammar programming language.

Masculine Polynomial
314 mm(width) x 445 mm(height)
Digital Print on Paper



Feminine Polynomial
314 mm(width) x 445 mm(height)
Digital Print on Paper

Masculine Polynomial • Generative Artwork based on Polynomial Functions which is developed by using a software to generate fractal images. And some additional image editing tools. In mathematics, a polynomial is an expression of finite length constructed from variables (also known as indeterminates) and constants, using only the operations of addition, subtraction, multiplication, and non-negative integer exponents. This artwork is developed and rendered for both 2D and 3D printing. It's a study on creating human made fractal structures using math and programming languages.

Feminine Polynomial • Generative Artwork based on Polynomial Functions (2D) which is developed by using a software to generate fractal images. And some additional image editing tools. In mathematics, a polynomial is an expression of finite length constructed from variables (also known as indeterminates) and constants, using only the operations of addition, subtraction, multiplication, and non-negative integer exponents. It's a study on creating abstract fractal geometry structures using math and programming languages.

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Gausian Music
10" x 8"
Archival print

Typically, my creation process runs through several stages. First I draw abstract geometric designs for executing my computer programs. I use the computer on different levels. Some of my computer programs produce two dimensional images; others are three — depending on my composition's final dictates. Then I add photographic content using scanners and digital cameras. The programs that produce two-dimensional artwork serve as a point of departure for photolithographs and photo silkscreened prints on canvas and paper. They are included both into my two-dimensional and three-dimensional works. All of these approaches are combined for image creation with the use of painterly markings as an archival quality digital print.

Gausian Music • The two disciplines overlap making visual music possible.

Playful Alternatives • It is like drawing a curve in one sweep.

Uneven Balance • Action May Not Equal Reaction.

Playful Alternatives
8" x 10"
Archival print

Uneven Balance
10" x 8"
Archival print

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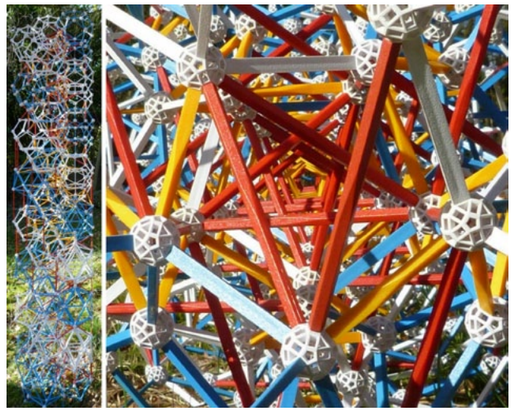
Labyrinthic EvaKnollization and St.Omerization of Grapefruit
diameter 90 mm
grapefruit and permanent black ink

Besides expressionistic painting and sculpting of the figure and portrait, I am recurrently drawn to geometric projects, probably by previous life experiences in engineering.

This year, two subjects specially triggered my interest. First, in relationship with this year's third paper on labyrinths at Bridges Conferences, I pushed the investigation of morphing these emblematic patterns onto spheres a bit further with a pair of two new citrilabs. Second, I fiddled around on a fifth Zometool model in my series of Platonic Extensions started in 2002.



Platonic Extensions V
2200 x 500 x 500 mm
Zometool blue, red and yellow regular struts, white 'blue struts' for architects and white balls

Labyrinthic EvaKnollization and St.Omerization of Grapefruit • The first comes almost fully from Eva Knoll's thoughts when she saw my elaborate transformation of her labyrinth that she asked me to 'citrize' during Banff 2009, and suggested a very nice alternative idea, so I just had to implement and further slightly enrich it for metaphoric aesthetics: think about an impossible icosahedron-like antiprism between pyramidal caps but in a cubic symmetry drum then blown up into a sphere to make it really happen, actually a drum with square rubber membranes pulled down to opposite rims... The second stems from Carlo Séquin's interest in my early expliciting a morphing between the Chartres and St.Omer labyrinths and reverse, augmented by the creation of Mini and Micro versions of the Labyrinth almost identically present in the town hall of Ghent, Belgium. Here a couple of deployed Minis are curled cylindrically then blown into a sphere, displaying twice the signature cross, square (here becoming polar circles), and dot of this historical monument.

Platonic Extensions V • This freestanding tower proposes a double white/blue helix edge-by-edge stacking, not only of the 5-axis Platonics, but also of three parts : the stronger, triangulated base, with icosahedra only, the middle, mixed part, where the white icosas change into dodecas, and the upper one with dodecas only. In between the two helices, all possible red and yellow struts but the shortest, provide interesting helicoïdal connections that form a pentagram core when seen axially through. (After a Zometool workshop project suggested by Dirk Huylebrouck, referring to a work by Gerard Carlis he turned into a biological metaphor, and further inspired by comments on Zometool specifics from Paul Hildebrand.)

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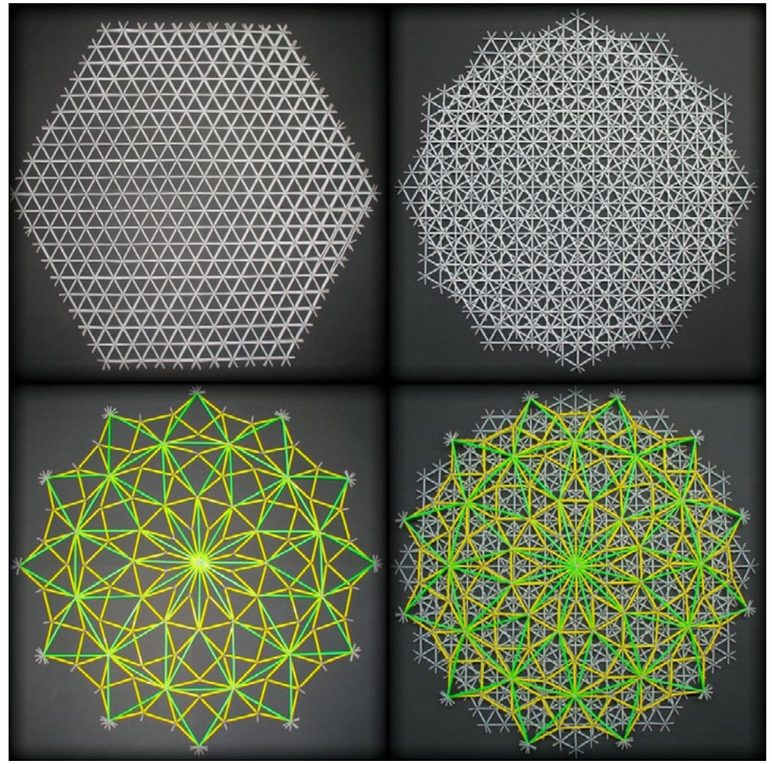

Fuzzy Precision (2D)
2 discs of diameter 80cm (one disc is interactive)
plastic tubes and connectors (Tubespace), colored soda straws

I create 3D forms to convey the notion that geometry is no mere tool of composition, it's an epistemology – a way to understand the world and to express its underlying laws. Each work seeks to employ the principle of economy to find the essential in a problem and to then "substantiate" it in a least-action solution which brings that essence to light and to life.

While using modern materials to explore classical questions, I often wonder how much further along we might be today if the great minds of the past had also had these materials for their earlier explorations.

Fuzzy Precision (2D) • Fuzzy Precision-2D shows the fractal structure embedded in the irrational √3 edgelengths created by overlaying, common-centering, and rotating identical triangular grids -- an interactive trip from pure periodicity to a sea of irrational near-misses to a highly-ordered √3-scaled hierarchy of nonperiodic tilings. To align the base grids, rotate the top grid to 0°. Rotate slightly away from 0° to see moiré interference patterns. Rotate to 30° to create near-misses of 3+ lines crossing at lengths of integer- and √3-multiples. You'll see scattered dodecagonal flower-shaped "rosettes" with near-miss centers that vary in their precision. If highest-precision centers are interlinked, a nonperiodic tiling results. Link the next-highest precisions, and you get an exactly similar nonperiodic tiling, deflated in the proportion √(2+√3):1. Two such tilings are shown in yellow and green on the second disc. A 3D variant with 5-fold symmetry will be constructed with Zometool at Bridges2011.

MARY WAHR

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BIrches
20x24
gouache and colored pencil on synthetic paper

I am an art educator with a Masters in Art Education. My thesis was based on fractal art and the premise that students can appreciate complicated mathematical concepts through art. What began as a research paper has turned into a passion. I draw fractals by hand in black and white and in color. Subject matter comes from nature, the human body and the techniques of the Surrealists, especially decalcomania. Decalcomania is a process where paint or ink and an art surface are pressed together. When the two surfaces are pulled apart an intricate, fractal pattern is created in the liquid medium. There are many variables that effect the outcome of the art piece including the paint or ink that is used, the type of paper and the direction of the pull. After a year my techniques are still evolving.

BIrches · Wings · Dante's Inferno · This is decalcomania. A thin coat of gouache is painted on a glass surface. Synthetic paper is laid into the paint and pressed to make contact. The paper is then pulled away from the glass surface. The tension created by the pull creates beautiful fractal patterns. These fractal patterns are self-similar in that all parts look the same. The patterns are at differing scales-small, medium and large. They are also recursive, building upon each other. These are components that mathematically define what a fractal is. Decalcomania makes these components visible.

WIngs
20x24
gouache and colored pencil on synthetic paper

Dante's Inferno
20x24
gouache and colored pencil on synthetic paper

JOSHUA WILSON

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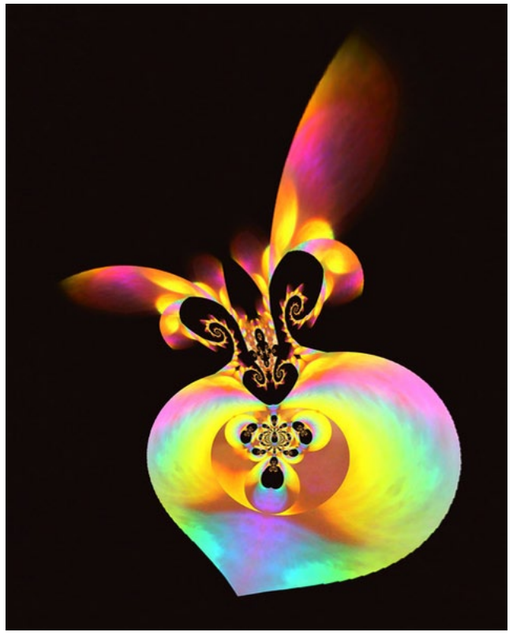
Acrylic Portal
24" x 20"
True Color Photographic Print on Fuji Crystal Archive Media

Initially inspired 19 years ago by the book "Symmetry and Chaos" by M. Field & M. Golubitsky, I sought out computer programs that produce images using algorithms. These "metafractals" are often based on subjects with obvious natural fractal properties. I see what inspired Benoît Mandelbrot to challenge Euclidean geometry and discover the true shape of the universe. I also find that the work functions as a Rorschach test, inviting modern psychology into the gallery as well. Both in creation and discussion, my work embodies the joy of discovery that strict scientist and dabbling alchemist share. In my work, one might see the beautiful intricacies of the Mandelbrot set, or simply an ethereal nautilus shell. My love of fractal mathematics, coupled with the "sampling" of the real world with a camera, makes this work so exciting to me. It bridges mathematics to psychology, photography to printmaking, and simulation to reality.

Acrylic Portal • Based on a photo of interior design elements, this piece has two infinity points that can easily be flipped by the mind's eye as foreground or background. This is what I call a "portal-type" Metafractal- one that suggests a door to another place, with perhaps very different metaphysical rules than this side...



Crystal Heart
24" x 20"
True Color Photographic Print on Fuji Crystal Archive Media

Crystal Heart • Initially designed as a Valentine, this image was produced from light shining through a diamond into the camera lens. I particularly like the intricate implied hyperbolic planes that twist above the body of the heart to form "wings". I call this an "object-type" Metafractal, as it could easily stand as a sculpture if rendered in 3 dimensions.

Blue Ganesh
20" x 24"
True Color Photographic Print on Fuji Crystal Archive Media

Blue Ganesh • This image was produced from a source picture of sand rivulets on a beach, tinted blue by a color inversion algorithm. Though there are many interesting individual patterns, the overall composition reminds me of an elephant's head, and therefore the elephant-headed Hindu patron of the arts and sciences, Ganesh (also known as Ganesha). Carl Jung would be proud...

MOHAMMAD H YAVARI RAD

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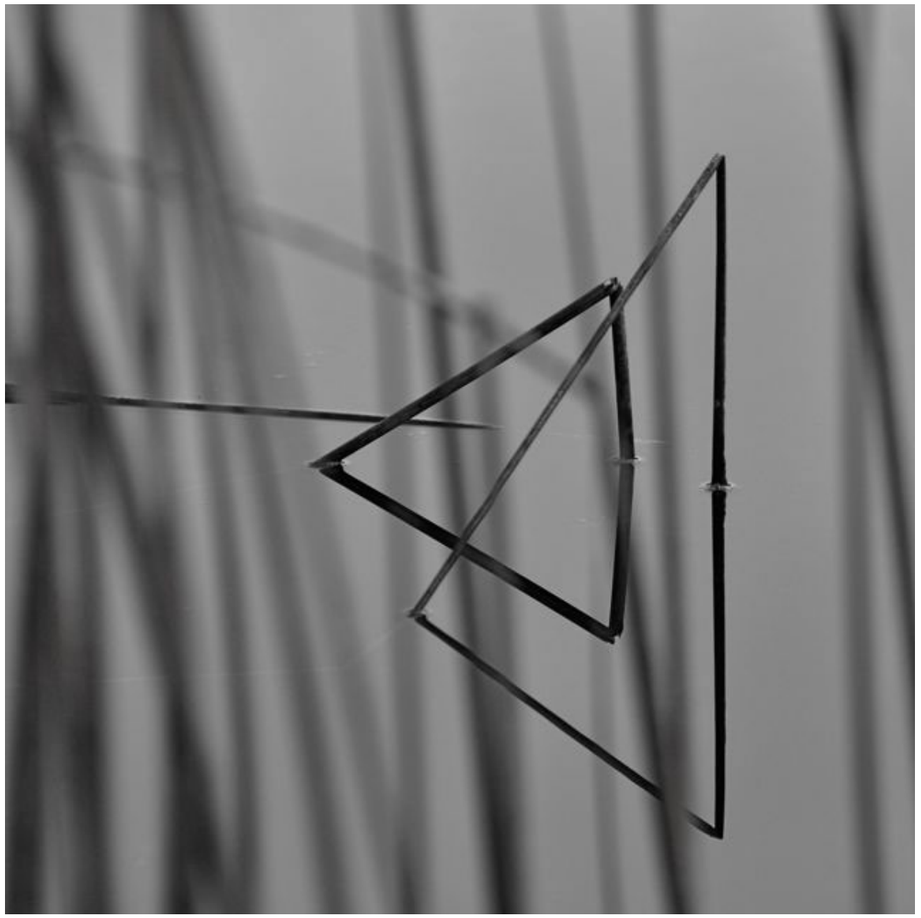


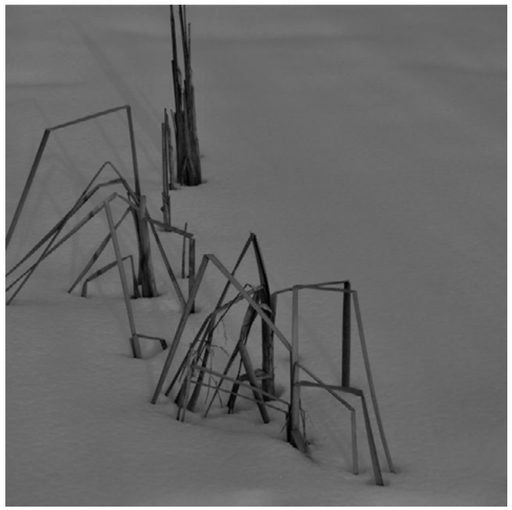
Nature's simple geometry
18"x 18"
Photography

I am a physician; photography is my hobby. I am interested in shapes, textures, light and shade. I would like to see and take pictures of ordinary objects in an abstract way. Many of them, particularly in Nature, show a mathematical harmony. Although I use a digital camera, I don't "photoshop" my images. I may crop some images, but usually try to find the best frame while I am shooting. Both "color" and "black and white" photography work for me, based on the subject and message.

Nature's simple geometry • Amazing shapes are created in nature; some with delicate planning such as beautiful patterns in plants or flowers, some by pure accident. Of course, the precise rules of Optics play an essential role to create this image.

Balance
18" x 22"
Photography

Balance • This seems almost impossible in real life. I think it is. Reflection helped me take this image first. Simple rotation of the image created illusion of an impossible form of balance.



Geometry workshop
18"x 18"
Photography

Geometry workshop • Amazing accidental shapes in nature.

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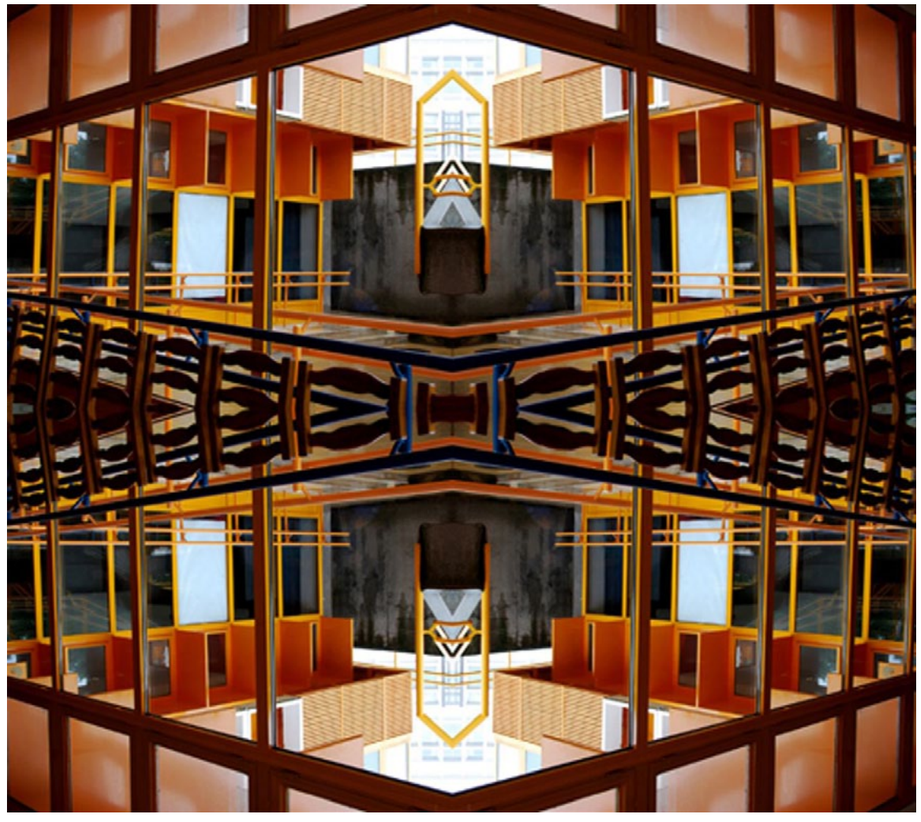
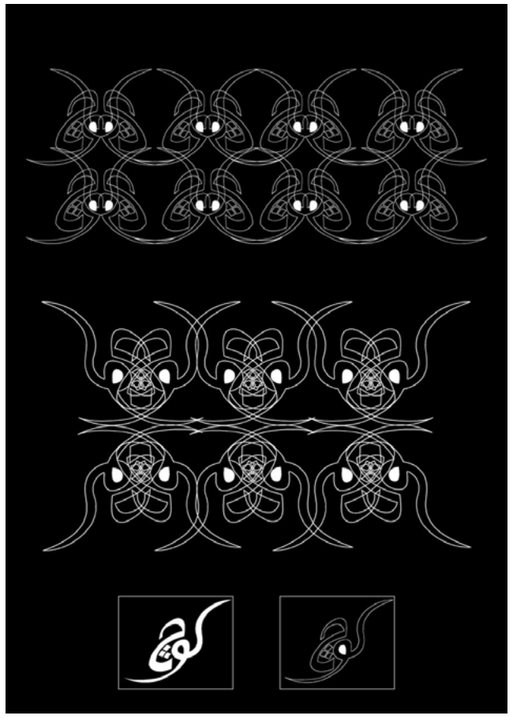


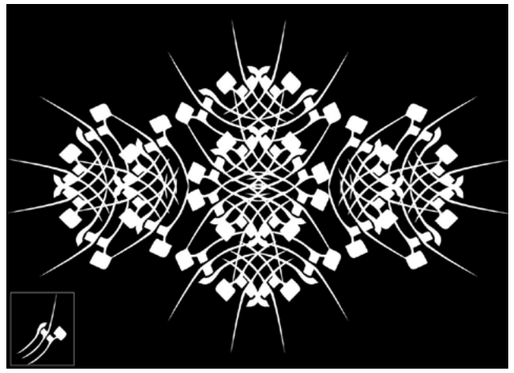
In-Out 1
Photography

I am a graphic artist. I like to design, paint, sculpt and take photographs. I sometimes mix different forms of media to create what I have in mind. I live in Iran which has a long history of art and craft making; perhaps the most authentic and famous one is "Persian rug". I like to use some traditional elements and mix it with contemporary concepts. One of the key elements of traditional Iranian (Persian) design is "symmetry". It has been reflected in rugs, tiles, crafts and architecture.

In-Out 1 • I like to create spaces which are not possible to create in real life. I use photography for that purpose. I first choose subjects with repeated elements such as straight lines. Reflection is another tool I use to create symmetric patterns. I also combine pictures using rotation or mirror images to create virtual spaces. This image shows rhythmic harmony. It creates the perception of both interior and exterior spaces and gives the sense of both moving inward and outward.



Kooch, traditional Persian design
Paper and ink



Molavi, Traditional Persian design
Paper and ink

Kooch, traditional Persian design • I use simple elements as building blocks to create more complex patterns. I repeat, rotate or slide them or use mirror images to create harmony and symmetry. In this design, I have used Persian calligraphy. The basic element in this design is the word "Kooch" means "Roaming" in Persian. First, I designed the world "Kooch" to facilitate its function as a building block. Then by using mirror images and repeating the image, I created this pattern. Similar patterns have been used in Persian tiles or architecture as margin.

Molavi, Traditional Persian design • Again in this design, I have used Persian Calligraphy. The basic element in this design is the word "Molavi", the Persian name for "Rumi". First, I designed the world "Molavi" to facilitate its function as a building block. Then by using repetition, rotation and mirror images, I created the the pattern. Similar patterns have been used in Persian tiles or rugs as center piece.

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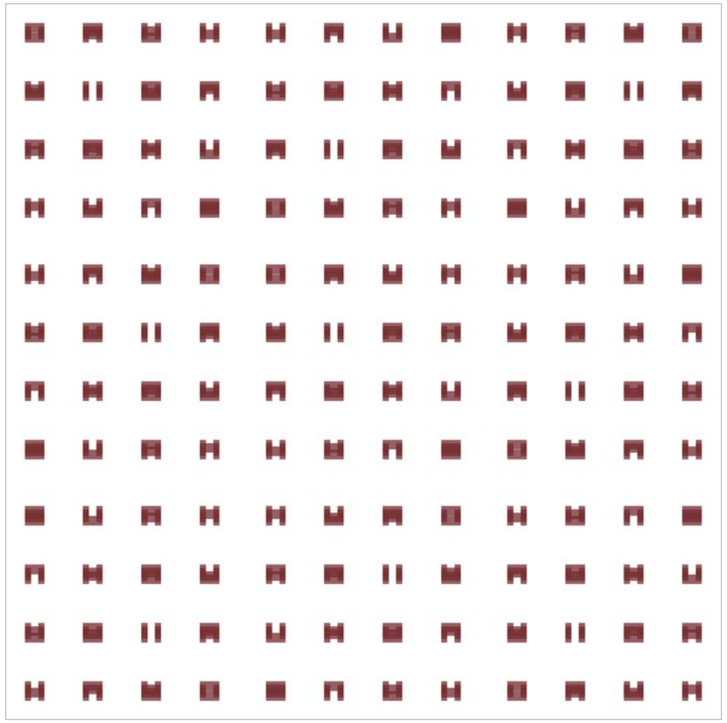


Magic Squares for Binary
20" x 20"
Digital print on canvas

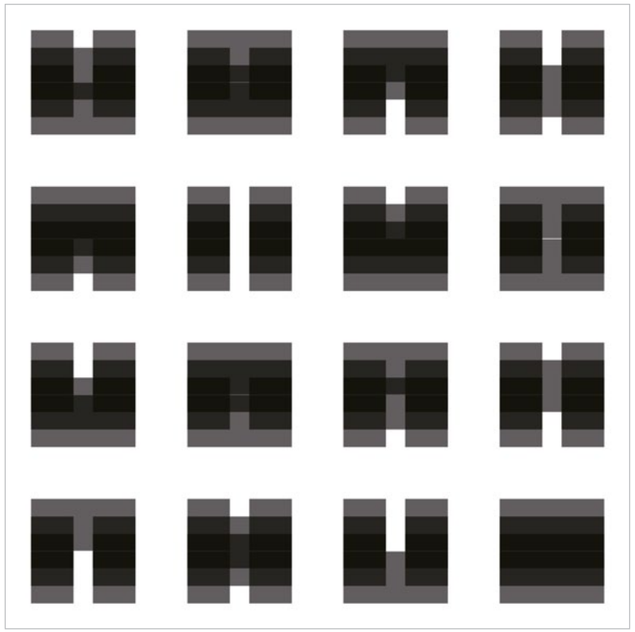
A magic square is known as the arrangement of n x n numbers, such that any column, row or diagonal adds up to the same number, the magic number.

The Lo Shu, known and discussed in China since long, can be considered the first known 3 × 3 magic square. For n equal to four, 880 magic squares can be constructed, neglecting rotation and reflection.

For the work presented here, it is assumed, order of some sort is a contributing factor to aesthetic value.

Because of their mathematical properties, magic squares are highly ordered entities. It is our conjecture as artists, that this order will show if transformed into a visual representation. Instead of designing or constructing order for an image, we use the inherent order of magic squares as an engine for the construction of aesthetic events, and we focus on the design of the visualization schemes which generate the images representing aesthetic events. A great number of such schemes is conceivable.

Magic Squares for Binary • For the example images on display, each base 10 integer from 1 to 16 of a 4 x 4 magic square is represented as a binary value, such as 1 → 0000, 2→0001, … , 15→1110, 16→1111. A long line represents a 1 in the binary string, and two short lines represent a 0 respectively. Based on the output of a program generating magic squares algorithmically, the integers 1 to 16 are turned into images keeping width, length, transparency of the lines and the spacing between lines as variables. Overlaps will occur and they are aesthetically wanted effects. Magic squares, often placed in the recreational corner of mathematics, offer interesting strategies to exploit mathematical order for algorithmically generated fine-art. A project, considering magic squares for aesthetic events has been carried out in 2010 by artists and programmers at the Media Research Center of Sun Yat Sen University in Guangzhou China.



Magic Squares for Binary 2
20" x 20"
Digital print on canvas

Magic Squares for Binary 3
20" x 20"
Digital print on canvas