Writing a Mathematical Art Manifesto

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Abstract

In this workshop, we will lay the groundwork for one or several mathematical art manifestos. We will try to clarify what we mean by mathematical art as an art form of creative human expression rather than a subfield of mathematics, a discipline or a pedagogical tool, and follow the general framework of artist manifestos that proliferated during the 20th and 21st centuries.

To Manifesto or Not To Manifesto?

The first art manifesto, the Manifesto of Futurism by Filippo Marinetti was splashed across the front page of the daily French newspaper Le Figaro on February 20, 1909. Inspired by Karl Marx's Communist Manifesto, it had the fiery language, movement and fast energy of its art, full of imagery of the newest technology, "pulsating, nightly ardour of arsenals and shipyards, ablaze with their violent electric moons; of railway stations, voraciously devouring smoke-belching serpents." Its aim was to introduce a new aesthetic in a country steeped in art history and deep traditions. He writes, "It is from Italy that we hurl the whole world this utterly violent, inflammatory manifesto of ours, with which we today are founding 'Futurism', because we wish to free our country from the stinking canker of its professors, archaeologists, tour guides and antiquarians." His manifesto was as much about naming and rejecting an old paradigm as it was about defining the style of Futurism itself.

The manifesto became a must for artist collectives seeking to distinguish themselves in the flurry of isms that exploded during the modernist age. It was waved about during moments of stagnation or upheaval, to announce a radical new direction and agitate a change in the status quo. As Alex Danchev wrote in his introduction of *100 Artists' Manifestos*, "to manifesto was to perform"; the theatrics in its writing style and declaration became an art form in and of itself.

In this workshop, we will begin to lay the foundations for a mathematical art manifesto. We will attempt to do this from the perspective of creative human expression, apart from its usefulness as demonstration, illustration or pedagogy. If we are to follow the prescription of naming and rejecting an old paradigm, then we will need not only to understand what we mean by mathematical art but also how this art rejects some artistic belief or norm. Some examples of rejected paradigms include representational art (paintings or sculptures must have a likeness to the thing they are representing), the art establishment controlling what can be considered good art, and the requirement that art be physically made directly by a human hand.

The workshop is planned to proceed as follows:

(a) The facilitator introduces manifestos and the goal of the workshop (5 minutes).

(b) In small groups, participants discuss *Question 1.* What is mathematical art, or math/art, as a physical manifestation of creative expression (rather than for a utilitarian or pedagogical purpose)? After 5 minutes, groups share their ideas. (15 minutes)

(c) The facilitator hands out images of artwork that may or may not be considered mathematical art according to this more narrow definition. In small groups, participants discuss *Question 2.* Are the

following works of art considered mathematical art according to your understanding of mathematical art as a physical manifestation of creative expression? After 15-20 minutes, groups share their ideas. (30 minutes)

(d) The facilitator goes more in depth into the structure of the manifesto. Examples of rejected artistic paradigms are presented. (5 minutes)

(e) In small groups, participants discuss *Question 3.* What established paradigm or tradition in art might we be rejecting through declaring that mathematical art or math/art is art? and *Question 4.* Specifically, what criticisms do we have about the established paradigm? After 10 minutes, groups share their ideas. (20 minutes)

(f) Facilitator leads in reflecting and creating an outline for a mathematical manifesto. (15 minutes)

Some may protest that this exercise would run counter to the welcoming and inclusive spirit of many mathematical artists, as evidenced by the atmosphere of the Bridges Conference. It can be argued that most, if not all artists use mathematics whether consciously or unconsciously, intuitively or through careful planning, through composition, proportion, line, shape and space. As one mathematical artist opined, if an artist decides that their art is mathematical art, then it is. Though magnanimous as this sentiment may be, there is some value in ascribing characteristics, setting some modest parameters and reflecting on what it is that drives this particular form of creative expression.

The following sections provide background, context and examples for the discussions.

A Recent History of Art that Uses Mathematics

It can be said that mathematical art can be found far back into the history of many cultures, the intricate tiling patterns of Chinese and Islamic art, the symmetry and proportions of Greek statues, or perspective in Italian Renaissance paintings. But we will focus here on artwork produced in the West in the 20th century and 21th century and only on visual art as a starting point, though this could be expanded to include other forms such as performance, music and poetry. For additional artwork and context, we recommend [5, 9, 15].

There were many mathematical developments that inspired artists in the 20th century. We see the fourth dimension and non-Euclidean geometries seeping into the work of Dadaist Marcel Duchamp, Surrealist Salvador Dalí, Suprematist Kazmir Malevich, and Cubists Pablo Picasso and Georges Braque. In these works, the mathematical ideas themselves were not the focus, instead, they served as metaphors for our transcendent experiences with sex, religion, non-objective feeling, and space-time.

From the 1860s through the 1930s, Felix Klein, Alfred Clebsch and many other mathematicians created mathematical models of curves and surfaces out of paper, plaster, string and wood. The models were beautifully crafted and displayed in science museums and math departments. Many artists became enamored with these otherworldly forms, including the Dada photographer and painter Man Ray, Constructivist artists Naum Gabo and Antoine Pevsner and the sculptors Barbara Hepworth and Henri Moore. Although Man Ray only photographed and painted these models, Gabo, Pevsner, Hepworth and Moore made their own works, guided by intuition and pattern rather than strict adherence to a mathematical equation.

Topology influenced the Concrete Art Movement led by Max Bill in the 1930s, which is around the time that M. C. Escher began to incorporate mathematical ideas into his artwork. Both Bill and Escher re-discovered mathematical ideas like the Möbius Strip and Riemann surfaces through their artistic experimentation. In the 1960s, Minimalism exploded onto the scene with artists like Sol LeWitt and Donald Judd using numerical sequences and combinatorics to create increasingly abstract works. Alongside came Op Art with Bridget Riley using mathematical formulas and precision to create her work.

Around 1980, Benoit Mandelbrot printed the first image of his Mandelbrot fractal using IBM's computers. The computer age brought a wealth of interest in visualizations of mathematical curiosities, similar to

the golden age of mathematical model making a hundred years earlier. Some of these images were just that, visualizations, but some mathematicians and computer scientists began to use the computer software programs as an artistic medium to produce images and three-dimensional objects that they deemed aesthetically pleasing. At the first Bridges Conference in 1998, Carlos Séquin presented the paper "Art, Math and Computers: New Ways of Creating Pleasing Shapes" that explained his process of using a computer to virtually design complex geometric shapes similar to minimal surfaces which could then be sculpted out of wood. It's interesting to note that we saw echoes of this in last year's Bridges Conference in 2024 with Shiying Dong's workshop, "From Knot Diagrams to Crocheted Topological Surfaces", which created similar shapes through a different process. These early computer-aided artistic movements took on names like Computational Art and Algorithmic Art.

In the 21st century, art with underlying mathematical themes and processes became a popular mainstay in the mathematical community. The Bridges Organization was founded in 1998 by mathematician Reza Sarhangi, the JMM Mathematical Art Exhibit began in 2004, and the SIGMAA Arts special interest group was formed in 2006. Mathematical art is still practiced among those who primarily call themselves artists, but more and more mathematicians have found an avenue of artistic expression through mathematical art.

So What IS Mathematical Art?

Interestingly, the most recent writings published in the AMS Notices have characterized mathematical art as a subfield of mathematics. The 2020 Mathematical Makers Manifesto written by Roger Antonsen calls mathematical making "the ultimate interdisciplinary subfield of mathematics". In the 2021 article *Mathematical Art as a Discipline* [4], Frank Farris writes, "mathematical art has become a discipline in its own right, with community norms, journals, and conferences." George Hart's 2024 article *What Can We Say About "Math/Art"?* [7] also places it within mathematics, or a liminal space in between, " It is not even clear where to place the field: is it a specific branch of applied mathematics or a separate discipline that emerged from math and art?"

Doris Schattschneider wrote in her review of the 2005 Bridges Conference [11] that "Mathematics creates art"; "Mathematics is art"; "Mathematics renders artistic images"; "Hidden mathematics can be discovered in art"; "Mathematics analyzes art"; "Mathematical ideas can be taught through art." This is all true, and expresses the myriad of ways in which mathematics connects to art. But what can we say if we focus on mathematical art as a form of creative expression, one that explores the beauty of mathematics for its own sake as its primary focus rather than for some utilitarian or educational purpose? If we declare that mathematics is art, or as George Hart calls it, "Math/Art", where does this take us?

Characteristics of a Manifesto

The impetus for writing a mathematical art manifesto came from George Hart's 2024 article in the AMS Notices, *What Can We Say About "Math/Art"?*. He says, "Should some type of Mathematical Art Manifesto be our formal goal? My view is that the congregation has not yet reached a level of consensus on the core values of mathematical art". Perhaps the prior discussions reveal this. But it's helpful to know that although Marinetti wrote the first Futurist Manifesto in 1909, over 50 additional Futurist manifestos were written over the next decade that explored different facets of Futurism, many written by Marinetti himself, with such titles as *Futurist Photodynamism*, *Manifesto of the Futurist Woman*, and the *Manifesto of Futurist Cuisine*. Certainly it may happen that groups with common views can come together to write separate manifestos.

Although manifestos look very different in style and content, some written in prose or poetic form, some written as short declarations in a numbered list, many follow a particular formula developed by Marinetti which involves the following three steps.

Step 1: *Identify and define an established paradigm in art.*

Step 2: *Criticize the paradigm (with strong passion).*

Step 3: *Introduce a new paradigm to counter the old (again with strong passion).*

A good manifesto according to Marinetti must have violence and precision, a specific accusation and a well-defined insult, wit and bombast, and a sense of style that mimics the art itself. This is only a suggestion; violence and bombast are optional.

Specific Artwork That May Be Considered Mathematical Art, Or Not

I list here some modern artwork may or may not be considered mathematical art. I deliberately avoided listing work by mathematician artists from the Bridges community, in part because these are already known.

1. Kazimir Malevich, *Painterly Realism of a Boy with a Knapsack - Color Masses in the Fourth Dimension*, 1915. Oil on canvas. MOMA, New York. The painting consists of a black square and a red square against a white background. Malevich interpreted the fourth dimension as a realm of pure feeling and consciousness that transcends space and time.
2. Marcel Duchamp, *Anémic/Cinéma*, 1926. Film. MOMA, New York. This short film is a collaboration with Man Ray consisting of a swirling optical illusion and nonsensical sentences that take on different meanings based on their position. A note written by Duchamp about this film says, "The cutting edge of a blade and transparency and X-rays and the fourth dimension".
3. Salvador Dalí, *Corpus Hypercubus*, 1954. Oil on canvas. Metropolitan Museum of Art, New York. The painting depicts Christ on a cross-like image of a hypercube unfolded into the third dimension.
4. Naum Gabo, *Two Cubes (Demonstrating the Stereometric Method)*, 1930. Painted wood. Tate, London. Two cubes, one solid and one with planes, showing the inner space of a cube rather than just its solid form.
5. Man Ray, *Shakespearean Equation: Twelfth Night*, 1948. Oil on canvas. Hirshhorn Museum and Sculpture Garden, Smithsonian Institution, Washington, DC. The painting was based on photographs taken of mathematical models in the Institut Henri Poincaré. He was using the models as the Dadaists used other found objects, removing them out of their usual context to stimulate imagination.
6. Max Bill, *Endless Ribbon*, 1953. Granite. Baltimore Museum of Art, Baltimore. This granite sculpture represents a Möbius Strip, a shape that Bill re-discovered through experimentation.
7. Barbara Hepworth, *Stringed Figure (Curlew)(Version II)*, 1956. Brass and string on wooden base. Tate, London. The sculpture is inspired by mathematical string models.
8. Jasper Johns, *Numbers in Color*, 1958-1959. Encaustic and newspaper on canvas. Buffalo AKG Art Museum, Buffalo. The painting depicts numbers 0 - 9 in a particular pattern, 9,0,1,...9 along the first row, 8,9,0,1,...,8 along the second row and so on until the first row is repeated. Though using a common commercial stencil, the numbers abstract to shape and texture through the use of color and encaustic, rendering them stripped of everyday meaning.
9. Donald Judd, *Untitled (Progression)*, 1969. Aluminum. Van Abbe Museum, Eindhoven. The sculpture consists of aluminum blocks in a progression whose widths are determined by the Fibonacci sequence. He was playing with the relationship between positive and negative space and rhythm.
10. John Sims, *Seeing Pi*, 2006. Fabric. This quilt is a conceptualization of pi using colors to represent numbers, to "capture the dynamic beauty of something seen as so logical and static - despite its unending and non-repeating nature" [13].

11. Bridget Riley, *Movement in Squares*, 1961. Tempera on hardboard. Arts Council Collection, Southbank Centre, London. The painting is a geometric optical illusion composed with the help of mathematical formulas, but executed meticulously by hand.
12. Georg Nees, *Schotter*, 1968-70. Lithograph on paper. V&A South Kensington, London. The image of neat rows of squares devolving into randomness was created using lines of code and a drawing machine reading the computer-generated graphic.
13. Vera Molnar, *Sainte-Victoire*, 1989-1996. Laser print on paper. The computer-generated, laser-printed engravings sketch Mont Sainte-Victoire depicted in Cézanne's artwork. It was inspired also by her investigations introducing random irregularities into the Gaussian to break its symmetric shape.

Quotes from Mathematical Artists

The art that is mathematical art must bring to mind a landscape of mathematical pleasure.

George Hart, artist and applied mathematician [7]

It is art that embraces the spirit, language and process of mathematics. Both maths and art are concerned with truth, but they differ in their ways of searching for it. Maths uses analysis and proof; art uses the senses and emotions. But maths can harness the spirit of creativity and art can be analytical. Together they form a great alliance for understanding the world around us. John Sims, artist [12]

What is Mathematical Art? I will choose work that meets at least one of the following three criteria: The art
1. is based on a Mathematical phenomenon, or
2. it is generated by a Mathematical process, or
3. it is a personal response to Mathematics by the artist.

Susan Happersett, artist [6]

I am convinced it is possible to evolve a new form of art in which the artist's work could be founded to quite a substantial degree on a mathematical line of approach to its content. Max Bill, artist [2]

By keenly confronting the enigmas that surround us, and by considering and analysing the observations that I have made, I ended up in the domain of mathematics. Although I am absolutely without training in the exact sciences, I often seem to have more in common with mathematicians than with my fellow artists.

M.C. Escher, artist [8]

For me, creating sculpture is a compulsion. ... Finishing a new sculpture is as satisfying as solving a difficult problem, when one's thoughts crystallize and the fog becomes clarity.

George Hart, artist and applied mathematician [7]

Rejected Paradigms from Art Manifestos

Below are examples of rejected paradigms from art manifestos. The first three and many more can be found in 100 Artists' Manifestos edited by Alex Danchev [3].

A work of art must be entirely conceived and shaped by the mind before its execution. It shall not receive anything of nature's or sensuality's or sentimentality's formal data. We want to exclude lyricism, drama, symbolism, and so on. Manifesto for Concrete Art, Theo van Doesbourg, 1930

5. We renounce the thousand-year-old delusion in art that held the static rhythms as the only elements of the plastic and pictorial arts. We affirm in these arts a new element the kinetic rhythms as the basic forms of our perception of real time. Realistic Manifesto, Naum Gabo, Antoine Pevsner, 1920

The black square on the white field was the first form in which non-objective feeling came to be expressed. The square = feeling, the white field = the void beyond this feeling. Yet the general public saw in the non-objectivity of the representation the demise of art and failed to grasp the evident fact that feeling had here assumed external form. The Suprematist square and the forms proceeding out of it can be likened to the primitive marks (symbols) of aboriginal man which represented, in their combinations, not ornament but a feeling of rhythm. The Manifesto of Suprematism, Kazmir Malevich, 1927

The computer can become a new means to understand the world. Long forgotten knowledge about geometry, mathematics, logic and about the thousandfold forms of reality might once again come to light. Science and art can be joined again. We may lose the unique irreproducible gesture of the artist, but we will gain a new way of thinking. Manifesto of Computer Art, Tamás Waliczky, 1989 [14]

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References

[1] A. Abrams et al.. "Mathematical Makers' Manifesto." *Notices Amer. Math. Soc.* vol. 67, no. 5, 2020, pp. 615.

[2] M. Bill. "The mathematical way of thinking in the visual art of our time." Week 3, 1949; translated in *The Visual Mind* ed. Emmer, M., MIT Press, 1993.

[3] A. Danchev, editor. *100 Artists' Manifestos: From the Futurists to the Stuckists*, Penguin Books, 2011.

[4] F. A. Farris. "Mathematical art as a discipline." *Notices Amer. Math. Soc.* vol. 68, no. 6, 2021, pp. 980–986.

[5] L. Gamwell. *Mathematics and Art: A Cultural History*, Union Square & Co, 2015.

[6] S. Happersett, "Guest editor's introduction." *Journal of Mathematics and the Arts*, vol. 14, no. 1–2, pp. 1–3.

[7] G. W. Hart. "What Can We Say About 'Math/Art'?" *Notices of the American Mathematical Society*, vol. 71, no. 4, 2024, pp. 520–525.

[8] E. Maor. *To Infinity and Beyond: A Cultural History of the Infinite*, Princeton University Press, 1987.

[9] S. Ornes. *Math Art: Truth, Beauty, and Equations*, Princeton University Press, 2019.

[10] M. Perloff. *The Futurist Moment: Avant-Garde, Modernism, and the Language of Rupture*, University of Chicago Press, 1986.

[11] D. Schattschneider. "Math and art in the mountains." Mathematical Intelligencer, vol. 28, no. 3, 2006, pp. 31–37.

[12] J. Hoffman."Q&A: John Sims on mathematical art." *Nature* vol. 464, no. 983, 2010.

[13] P. Lederer. "John Sims wants to have his oi, and see it too." SQR Daily, 2019. https://www.srqmagazine.com/srq-daily/2019-03-13/10272_John-Sims-Wants-to-Have-His-Pi--and-See-It-Too.

[14] T. Waliczky. *Manifesto of Computer Art*. 1989. https://www.waliczky.com/pages/waliczky_manifest_eng.htm

[15] The Bridges Organization. *Mathematical Art Galleries*. 2024. https://gallery.bridgesmathart.org/