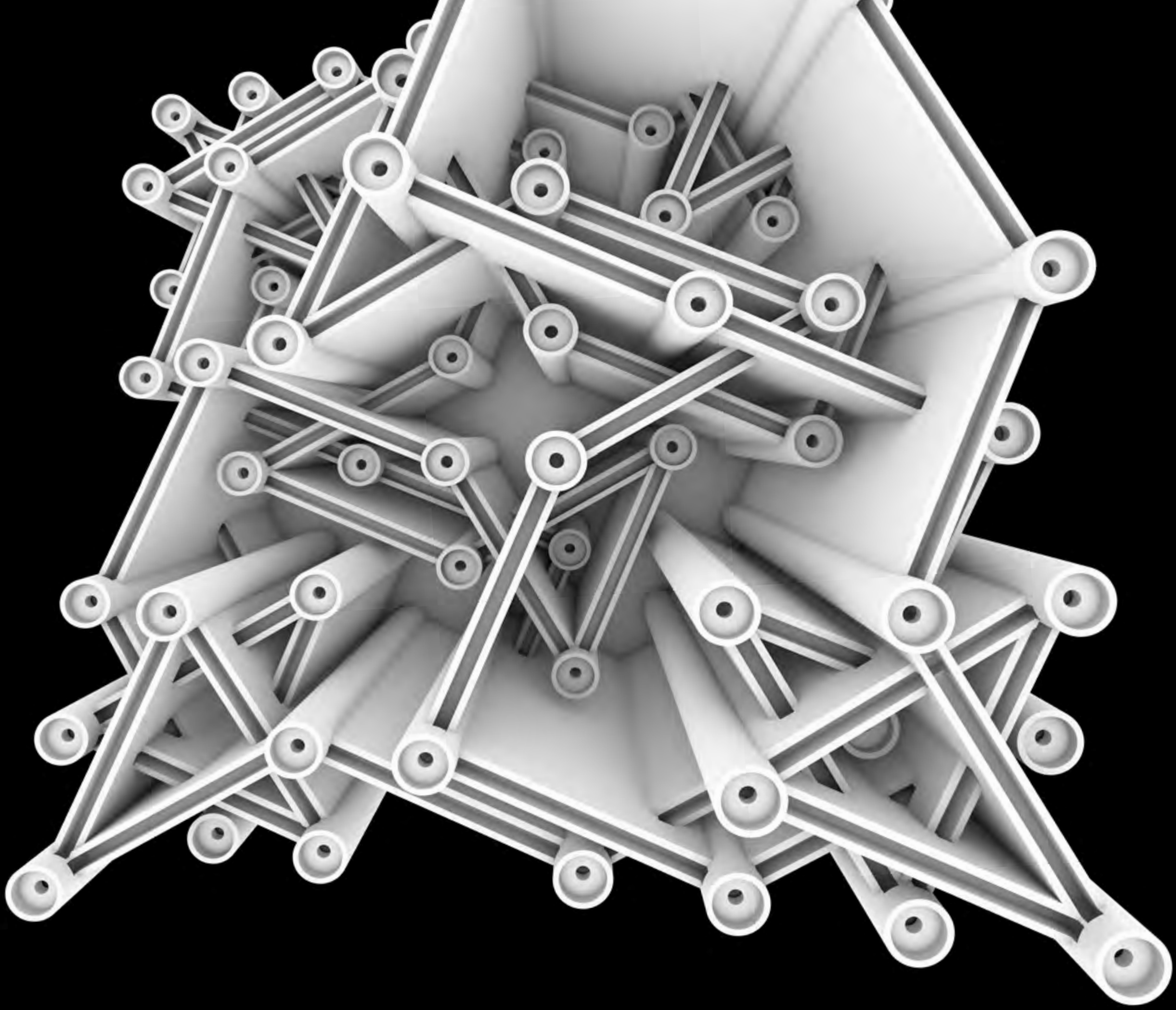

Intersection of Art and Science II

An educational exhibition at the Lawson Computer Science Building
Purdue University // January 8, 2018 — December 20, 2019

Manuel Baez // Sarah Berube // Robert Bosch and Sage Jenson // Jean-Marc Castera // Marc and Marion Chamberland // Laura De Decker // Bathsheba Grossman // Colin Liotta // Vincent J. Matsko // Kerry Mitchell // Janna Schimka, Rolf Schmuck, and Markus Schwehm //

INTERSECTION OF ART AND SCIENCE II Exhibition

January 8, 2018 through December 20, 2019

Lawson Computer Science Building
3rd Floor Exhibition Space
Purdue University
West Lafayette, IN USA

This educational exhibition examines a wide range of expressive approaches that emerge in the intersection of art, science, and technology. It is a joint collaboration between the Department of Computer Science and the Patti and Rusty Rueff School of Visual and Performing Arts at Purdue University. The exhibition was curated by Dr. Petronio Bendito and Dr. Tim Korb.

Department of Computer Science
cs.purdue.edu

Patti and Rusty Rueff School of Visual and Performing Arts
cla.purdue.edu/academic/vpa/ad

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Intersection of Art and Science II Exhibition
January 8, 2018 through December 20, 2019

Lawson Computer Science Building
3rd Floor Exhibition Area
Purdue University
West Lafayette, IN USA

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In addition to the current exhibition documented in this catalog, works currently on display in Lawson include the “Echo Spiral” (John Misler) stainless-steel sculpture in the Kurz Lobby, “A Parade of Algorithmic Mathematical Art” (Greg Frederickson) featuring geometric dissections, “The Quartet Collection” (Clifford Peterson) of original art that has been altered and multiplied using digital tools, and “Experience Color” (Petronio Bendito) that uses computational processes to explore digital color aesthetic.

Creative Processses Involving Science, Computing and Aesthetics

Petronio Bendito and Tim Korb

We are pleased to showcase a new set of artworks in this 2nd edition of the Intersection of Art and Science Exhibition! This international invitational exhibition features fifteen artists and art collaborators that apply scientific processes to the creation of visual expressions. It is the latest in a series of exhibitions that examine the melding of art and science in the creation of visual expressions, a goal stretching back to 2005 during the planning of the Lawson Computer Science Building. It contributes to the creation of a teaching, learning, and working environment that inspires and engages students, faculty, and visitors. By fostering computational visual literacy, it is our hope that the works in the exhibit will promote collaborations and interdisciplinary thinking and educate our students to engage with the increasingly growing role that computational and visual processes play in the creation of real and virtual experiences.

Participating artist Jean-Marc Castera points out that a practice based on art and science eliminates a feeling of ”any discontinuity between a left and right part of [his] brain.” Several of the works in this exhibition have a direct connection to computer science education, and even art history. For example, in beginning computer science classes, students learn about the importance of binary concepts—“Kandinsky in Binary” (Marc and Marion Chamberland) and “Sierpinski” (Vincent J. Matsko) illustrate binary numbers and binary trees, respectively. Visually, they show the possibilities in combining geometric shapes and color to suggest rhythm, organization, and, in the case of Sierpinski, texture. A common solution to the knight’s tour chess problem is often used to illustrate recursive programming, a tricky subject with which beginning students often struggle—“The Knight Tours the Castle” (Robert Bosch and Sage Jenson) is an elegant depiction of one solution to this puzzle. It exemplifies the role that constraints play in building a cohesive visual expression. More advanced computer science students learn about fractals and the properties of random numbers—“Newton in Wackyland” (Kerry Mitchell) is an innovative, artistic application of Newton’s methods to fractals. It also shows the increasing role that computational processes play in contemporary color design methods, while “Dancing birds for Reza” (Jean-Marc Castera) shows that random numbers can produce surprisingly stable results.

Students studying computer graphics use 3D printing to help visualize complex computer models and mathematical shapes—“Double Schwarz D” (Bathsheba Grossman) and “Entangled Snowflakes” (Sarah Berube) are printed 3D models of a minimal surface (like a soap bubble) and an icosahedron of snowflakes (like a soccer ball), respectively. Translating continuous equations into discrete steps is central to much of numerical computing—“Exploding Outwards” (Colin Liotta) shows that the discrete nature of a physical model with repeating pieces can lead to a continuous view.

Quantum computing involves collaboration among computer scientists, physicists, and engineers in the development of arguably the next frontier in computing—“Interference Pattern of Quantum Random Walk” (Laura De Decker) illustrates one of the complex and non-intuitive concepts in the quantum universe. Modeling life itself is another leap in computing—“Turing-McCabe Pattern” (Janna Schimka, Rolf Schmuck, and Markus Schwehm) explores real-time use of these patterns to understand movement, music, and visuals.

Some real-world objects with complex shapes and physical properties are extraordinarily difficult to model with computer algorithms—the wooden shapes in “The Light Keeper” (Manuel Baez) illustrate this challenge to computer model makers.

As showcased in this exhibit, math and computing processes are powerful creative tools. We hope this exhibition contributes to building a great understanding of how art and science are not mutually exclusive. The works exhibited characterize new possibilities of human experiences and expressions—from purely aesthetic enjoyment to the development of deep and sophisticated concepts.

The Light Keeper (2014-2016)
by Manuel Báez
Snap to grid version 25” x 25”
Originally Ceremonial Space, 21 foot diameter
Birch Plywood, Wiremesh, Stainless Steel Fittings

emergence
complexity
self-organization

topology
bio-design
morphology

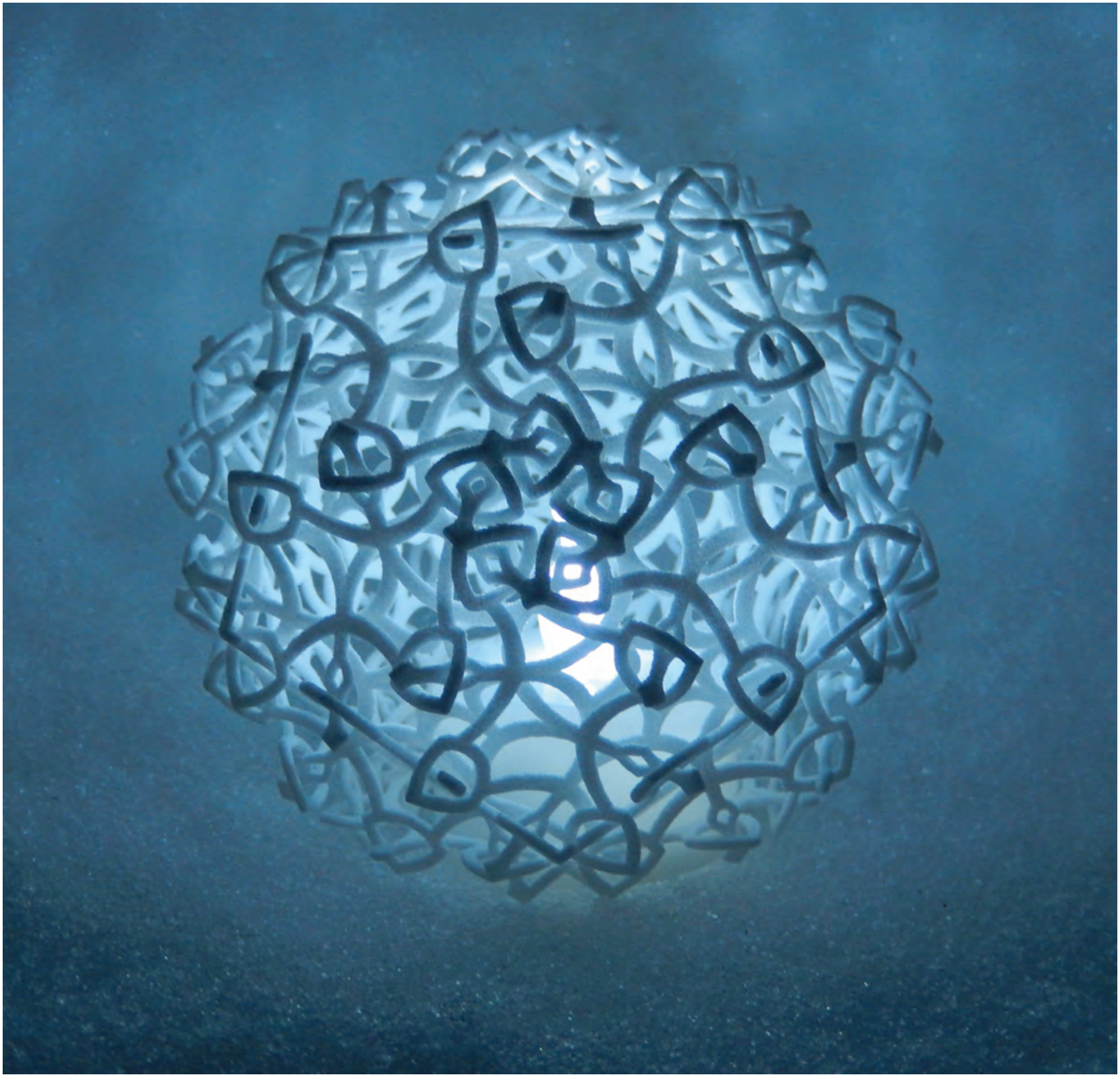
My work as an architect and artist draws inspiration from the forms, structures, and integrative systems generated by elemental processes that exist throughout the natural environment and how related developments in science and mathematics can provide insights into their inner workings. Modern analytical tools and such related theories as Complexity and Emergence are revealing a richly diverse morphological realm with implications towards architecture, engineering, design, art, and other disciplines. This deeper understanding of complex phenomena reveals how these fertile processes inherently engage elemental relationships that dynamically evolve into rhythmically-entrained patterns within highly integrative systems. The analysis of this generative potential and its interrelated cellular units and self-organizing patterns can yield more comprehensive understanding of emergent complex morphology.

The Light Keeper is made from two basic materials: 1/8” thick birch plywood, cut along the grain into 5’ long and 4” wide malleable strips and woven wiremesh fabric. The de-formability of the plywood strips is explored through the inherent morphological shapes that can be generated and combined. These material properties are due to the fibrous grain direction and strip size, which generates specific shapes and possible combinations. The wiremesh sheet is also very de-formable due to the flexibility of the wires (fibers) and the initially-orthogonal but variable angle between them. By combining this material property with an overall origami folded pattern, a membrane is made with highly de-formable emergent properties that can generate organic shapes and inherently dynamic combinations.

The design process starts when the ends of a plywood strip are overlapped together, creating a circular frame that recalls that of a traditional native drum. Where strip-ends overlap, a central pivoting joint allows the ends to rotate, deforming the frame and re-aligning the end corners. This allows for extension strips to be added and woven together through their de-formability. The circular frame, pivoting joint, and woven extension sequences generated the overall emergent design patterns. Similarly, the interactions between the round wires of the mesh and the hinging origami folds are the source of the membrane’s emergent de-formability. Thus, dynamic circularity is inherently embodied throughout the design reflecting its form generating capabilities through a material and dynamic configuration.

Manuel Báez **//** Carleton University, Azrieli School of Architecture and Urbanism, Canada. Báez has been at Carleton University since 2001. Previously, he taught at The Cooper Union for the Advancement of Science and Art in New York City and Rhode Island School of Design in Providence, RI. The eminent scholar Martin Kemp has featured Báez’s research in Structural Intuitions: Seeing Shapes in Art and Science, 2016. Recently, Báez won the Canada 150 Heritage Canada Dream competition with his design The Gather-Ring. In 2010, he was a guest speaker at TEDxCarletonU and the work received a Carleton Research Achievement Award in 2005. Báez received his B. Arch. Degree from The Irwin S. Chanin School of Architecture at The Cooper Union and his M. Arch. Degree from the Cranbrook Academy of Art.

carleton.ca/architecture/profile/manuel-baez



Entangled Snowflakes (2016)
by Sarah Berube
Snap to grid print version 25” x 25”
Originally 8 cm x 8 cm x 9 cm
3D Printed Nylon Plastic, LED Tealight

polyhedral symmetry
geometric patterns
3D printing
sphere
modeling
lighting

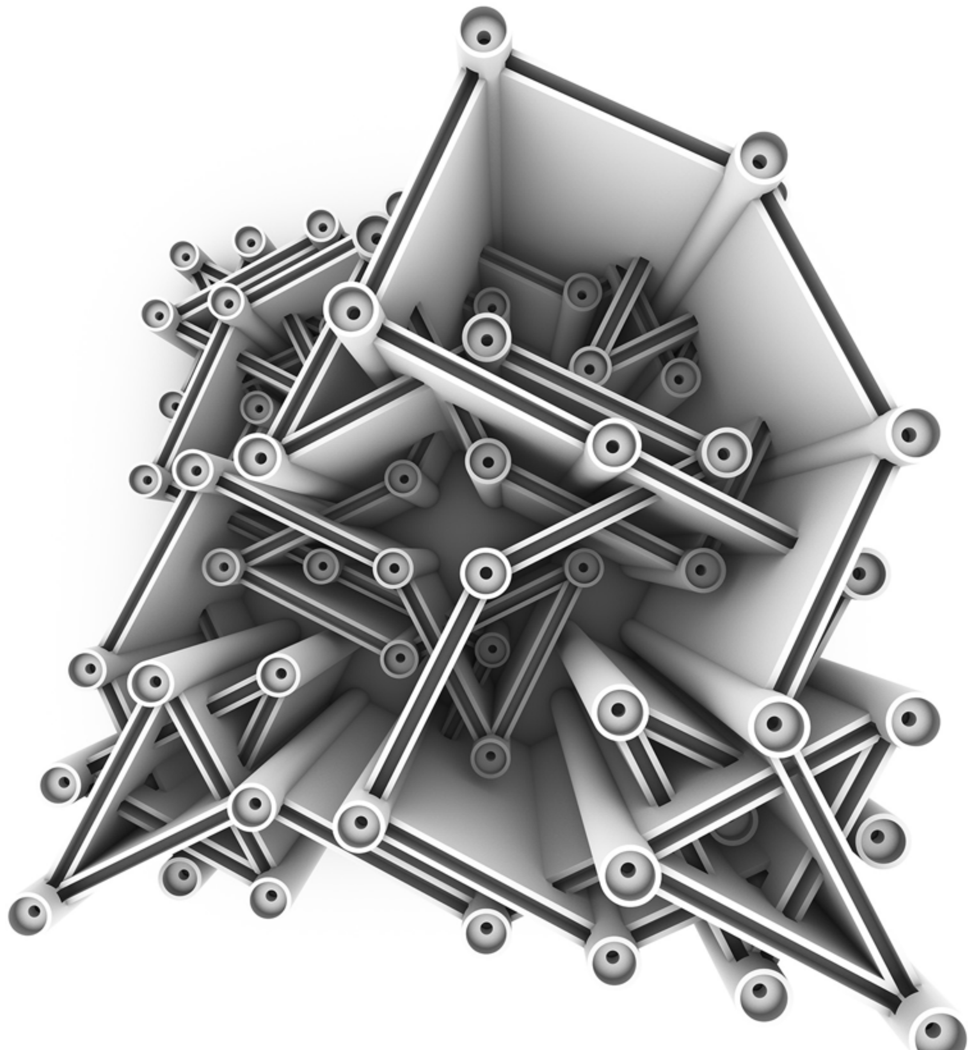
My work revolves around symmetry, most notably the polyhedral symmetry groups. The structure provided by mathematics serves as a foundation and inspiration for my creativity. My artistic practice involves an in-depth exploration of the properties of polyhedra. I love learning about these shapes as I discover and create my designs. The process appeals to me because it allows me to be both analytical and creative at the same time, striking a balance between aspects of the human mind that are often considered diametrically opposed (hence the name Diametric Arts). The word “diametric” also means “relating to a diameter,” which ties in nicely to the fact that my works can be circumscribed by either a sphere or a circle.

“Entangled Snowflakes” is a symmetric arrangement of twenty identical snowflakes that are all interconnected. I utilized rotational icosahedral symmetry when designing this piece. The result is that there are twelve nodes where five snowflakes connect at their tips. This is analogous to the five triangles found at the twelve vertices of an icosahedron. If the snowflakes were to be translated radially outward, they would eventually meet at their tips once again. In the resulting arrangement they would resemble the hexagonal faces of a truncated icosahedron, a polyhedron most commonly recognized as the form of a soccer ball.

My original intention was to find a snowflake whose shape would allow multiple iterations to pass through each other without touching. I accomplished this through freehand experimentation with 3D modeling software. Once the design was complete, I created an opening to accommodate an LED tealight. The model was then printed by an outside company using Selective Laser Sintering. Through this additive manufacturing process, nylon powder was fused together, layer by layer, to produce the finished product. The photo shown is one that I took after placing the illuminated piece in a hole dug into the side of a snowbank.

Sarah Berube // Diametric Arts. Sarah Berube studied the Sciences—Biology, Physics, Mathematics—at UMass Lowell before moving on to Art. After learning how to use SketchUp (3D modeling software) for woodworking projects in 2010, she began using it to study polyhedra. This experience allowed her to better understand mathematical modeling, including such inspirations as the sculpted works of George Hart at Stony Brook University. The result was an opportunity to reconcile her seemingly opposing passions for both Art and the Sciences, especially Mathematics. The 3D printing revolution opened up the door for Sarah’s designs to be brought to the physical world. In 2015, she founded Diametric Arts to share her creations as a demonstration of the beauty that lies within Mathematics.

www.diametricarts.com



The Knight Tours the Castle (2017)
by Robert Bosch and Sage Jenson
Snap to grid version 25” x 25”
Originally 12” x 12”
Digital Print on Aluminum

optimization
constraints
knight’s tour

The mathematicians in us are fascinated by the various roles that constraints play in optimization problems: sometimes they make them much harder to solve; other times, much easier. And the artists in us are fascinated by the roles that constraints play in art. All artists must deal with constraints, and many artists choose to impose constraints upon themselves.

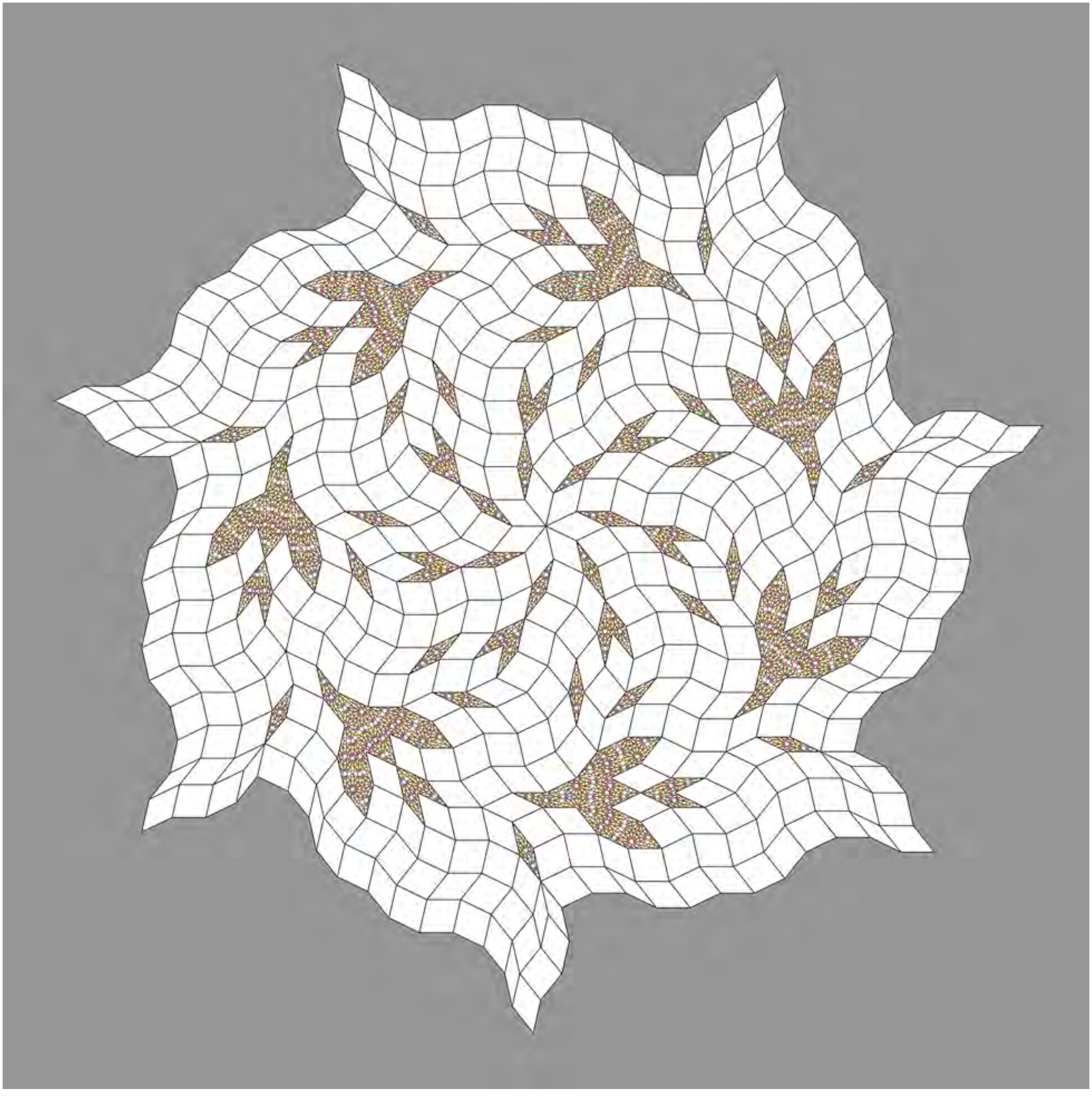
The Knight Tours the Castle is a parallel perspective render of a 3D model of an almost 4-fold symmetric knight’s tour of a standard chessboard. The heights of the turrets vary in accordance with their position on the tour. The tour is at its lowest point at the start/finish and is at its highest point midway through. The varying heights make it easier for viewers to follow the tour with their eyes.

Bosch devised an integer programming model for finding a knight’s tour that has 2-fold rotational symmetry and is as close as possible to having 4-fold rotational symmetry. He used OpenSCAD to create a 3D model of the tour, adding turrets and walkways to make it look more like a castle. Jenson transformed the 3D model into the final 2D piece.

Robert Bosch // Oberlin College. Bosch is Professor of Mathematics at Oberlin College. He specializes in optimization, the branch of mathematics concerned with optimal performance. Since 2001, Bosch has devoted increasing amounts of time and effort into devising and refining methods for using optimization to create pictures, portraits, and sculpture. He operates www.dominoartwork.com, from which it is possible to download free plans for several of his domino mosaics. His sculpture “Embrace” was awarded first prize at the 2010 Mathematical Art Exhibition in San Francisco.

Sage Jenson // Jenson is a Berlin-based artist who is interested in constructing realities. Jenson is a recent graduate of Oberlin College and Conservatory, majoring in computer science (with highest honors), mathematics, and TIMARA (Technology In Music And the Related Arts).

www.dominoartwork.com



Dancing Birds for Reza (2016)
by Jean-Marc Castera
Snap to grid version 25” x 25”
Originally 54 cm x 58 cm (21’’ x 22’’)
Mixed Media

geometric patterns
quasicrystals

symmetry
birds

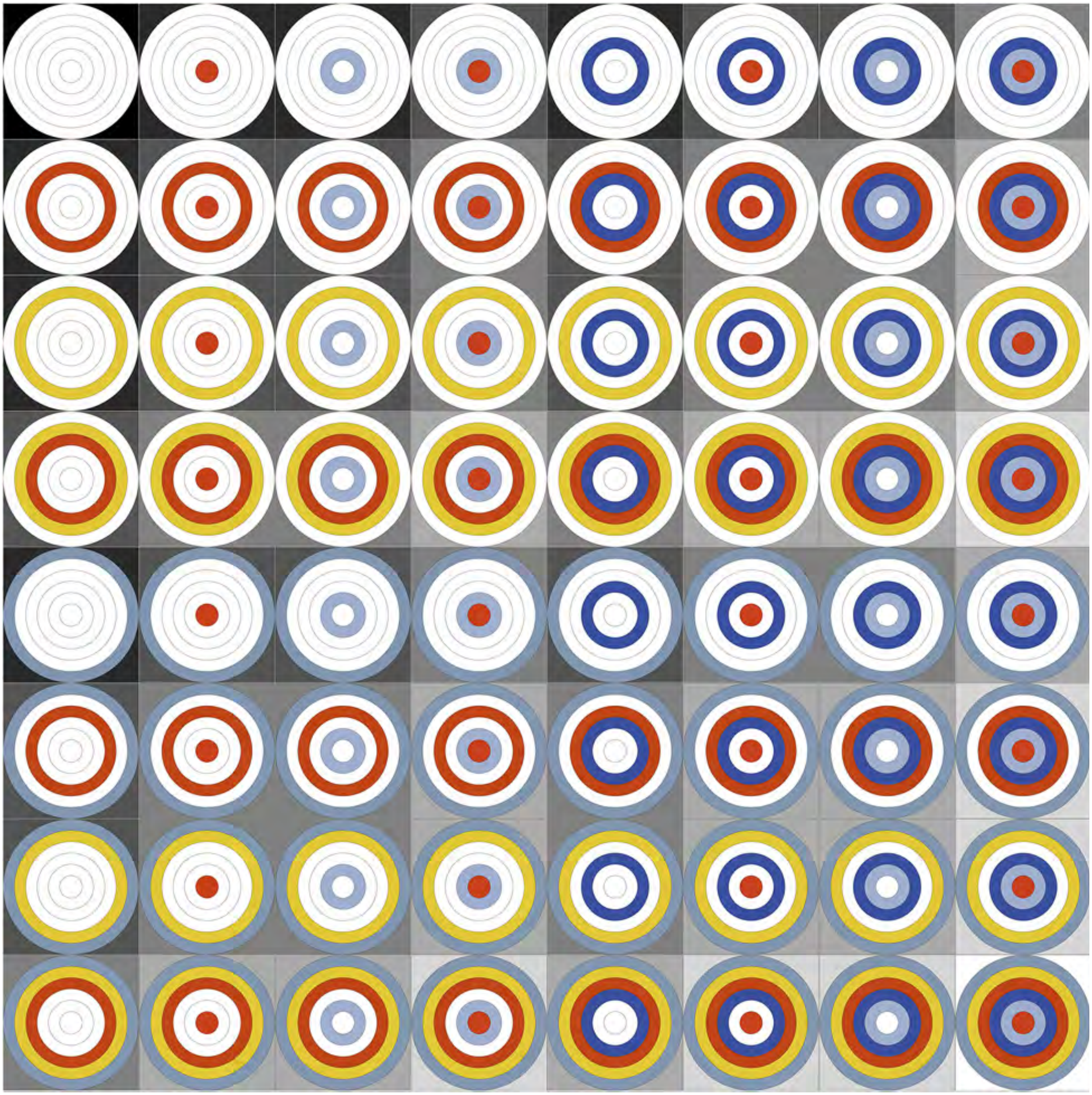
My practice brings together my artistic sensibility and my taste in mathematics. Doing that, I do not feel any discontinuity between a left and a right part of my brain.

This work is a 7-fold structure made of two layers. One is a 2D quasicrystal with local heptagonal symmetry, the second is a pattern in the Moroccan style that matches the first. I did it just before my friend Reza Sarhanghi passed away.

That work comes after a project in architecture. Aftermath, one night I was playing with this system, exploring its possibilities. And on the morning, when I came back to my computer after a little rest, the birds were here. I had just sown feathers, and the birds came by their own. This demonstrates that randomness exist, and can be creative, even in that kind of activity.

Jean-Marc Castera // France. After teaching at Paris 8 University, where he created an experimental course on “Mathematic and Art”, Castera worked in 3D modeling and animation in the early years of computer images. Then, he worked full time on Geometric design. He published two books on Traditional Geometric patterns in Morocco and Andalusia.
The second one, “Arabesques”, is considered the reference book on this subject. He regularly publishes articles in this tradition... and beyond. His participation in architectural projects with Norman Foster has been the perfect occasion to experiment with new ideas for a revival of geometric art.

castera.net



Kandinsky in Binary (2016)
by Marc and Marion Chamberland
Snap to grid version 25” x 25”
Originally 21” x 21”
Digital Print

Kandinsky
circles
binary numbers
symmetry
color

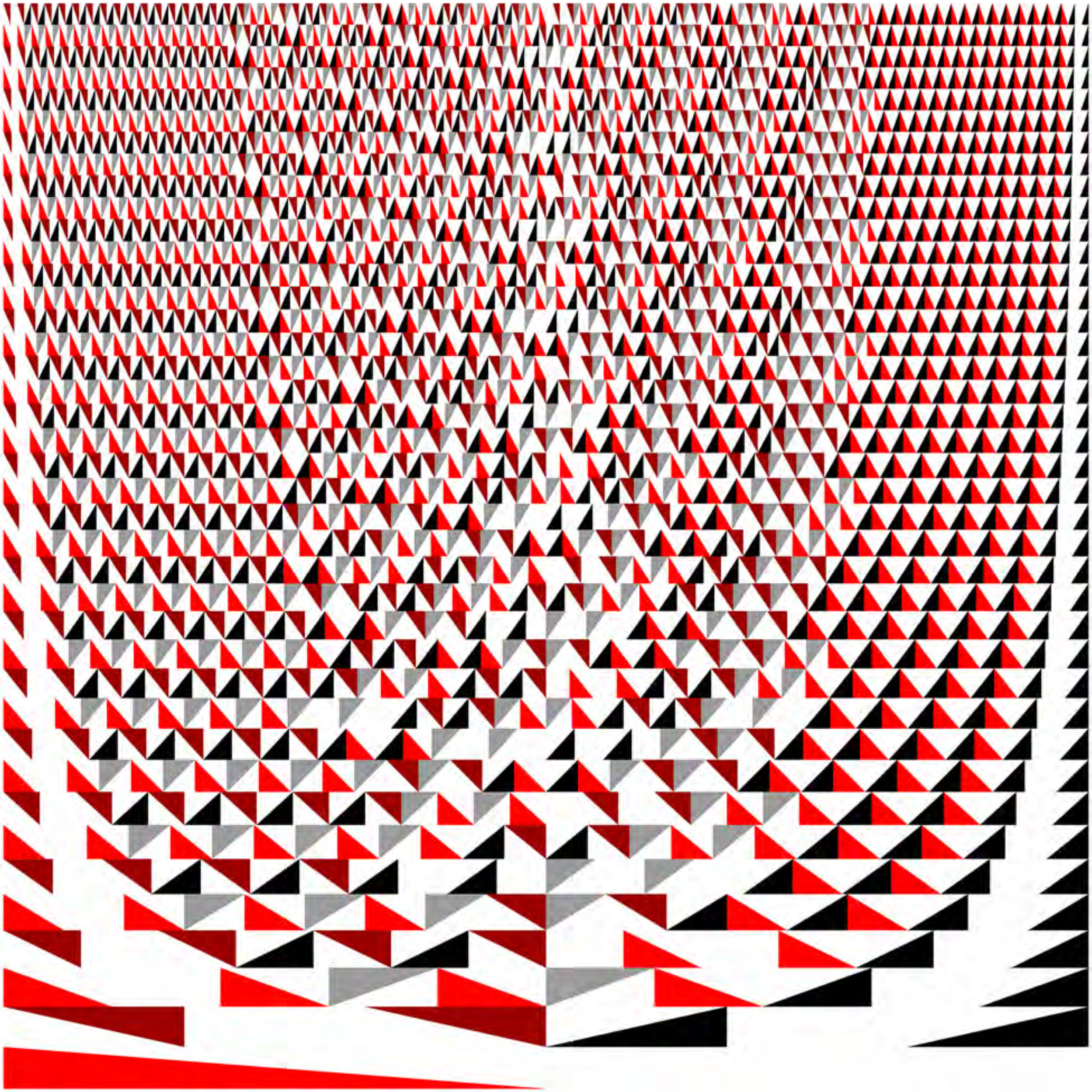
Marc Chamberland is the Myra Steele Professor of Mathematics and Natural Science at Grinnell College. He has published roughly 50 research papers and the trade book “Single Digits: In Praise of Small Numbers” (Princeton). Marc seeks to show the wonders of mathematics to a wide, general audience. His mathematical artwork has been displayed in several juried exhibitions and he is the creator of the YouTube channel “Tipping Point Math”. Marion Chamberland has produced creative works in ceramics, photography, and landscape design. This is the Chamberlands first joint work.

This piece was inspired by Vassily Kandinsky’s “Color Study, Squares with Concentric Circles” from 1913. The 64 sets of concentric circles represent the numbers from 0 to 63. Each of these numbers can be represented in binary, or base two, with six binary digits. The shading in each circle is on or off depending on whether the corresponding bit is a one or zero. For example, if the innermost circle is shaded red, the value one is contributed to the sum. If the next circle is shaded light blue, the value two is added to the sum. Adding up all of the appropriate powers of two generates the number for each set of circles. For example, the set in row 4, column 6 represents the number 29 because four of the circles are shaded and generate $1 + 4 + 8 + 16 = 29$.

This study started with an effort to visually represent binary numbers. By collapsing the famous Towers of Hanoi onto a plane and finding inspiration in the studies of the artist Kandinsky, we arrived at the structure of our image. It was generated using Maple, a computer algebra system. This is the Chamberlands’ first joint work.

Marc Chamberland // Grinnell College. Chamberland is the Myra Steele Professor of Mathematics at Grinnell College. He has published roughly 50 research papers, the trade book “Single Digits: In Praise of Small Numbers” (Princeton). Marc seeks to show the wonders of mathematics to a wide, general audience. His mathematical artwork has been displayed in several juried exhibitions. He also is the creator of the YouTube channel “Tipping Point Math”.

Marion Chamberland // Marion Chamberland has produced creative works in ceramics, photography, and landscape design.



Interference Pattern of Quantum Random Walk (2017)
by Laura De Decker
Snap to grid version 25” x 40”
Originally 24” x 24”
Giclée Print

quantum random walk
interference superposition

abstraction
spin coin
entanglement

I am a visual artist using mathematics and computer programming as a creative tool, since 2001, to create large-format abstract prints, video sequences, or interactive multimedia environments. My artistic interests intersect with concerns of quantum information because both are engaged with the dualistic properties of our world, including object and subject, theory and practice, art and science, modernism and post-modernism, classical and quantum, wave and particle, psychological and physical, and digital and analogue; these are at the heart of fundamental physics and my creative explorations. I learned how to program because I wanted to create images that require precise color and geometry; the computer allows me to test countless ideas and variations, in iterations that inform subsequent artworks.

This image shows the interference pattern of unmeasured potential quantum random walk states over time. Time starts at the bottom row and progresses toward the top. For each time-increment there is a coin (Hadamard) and a spin (a quantum system with two energy levels: up and down) operation. The ‘right-moving’ up spins interfere destructively while the ‘left-moving’ down spins interfere constructively. The coin operation produces superposition spin states – both spin up and spin down. The position and spin become more entangled through time. The probability of a random walk being measured in a certain position horizontally, shifts away from the center faster than in the classical random walk. Reference: J. Kempe. Quantum random walks – an introductory overview. arXiv: quant-ph/0303081v1.

This artwork is a direct translation of the math (i.e., Dirac or matrix notations) with numerous aesthetic decisions: time goes from the bottom of the image toward the top as time advances; expanding and ordering up and down spins to span the width; focusing on the interference pattern rather than probabilities to make the pattern more apparent; choosing an initial state that creates asymmetry; color to enhance the pattern; and using triangles as a notation. The color and triangle orientation correspond to sign (positive or negative numbers) and spin: black are plus up; grey are minus up; bright red are plus down and dark red are minus down. I wrote a computer program to create this image using Visual Basic.

Laura De Decker // Canada. Laura De Decker has a BA(Hon) in Art and Art History from University of Toronto and Sheridan College, and an MFA in Visual Arts from University of Victoria, British Columbia. She was artist-in-residence in 2012 for Christie Digital/ CAFKA (Contemporary Art Forum of Kitchener + Area), and in 2015 for Institute for Quantum Computing (IQC), at the University of Waterloo. She received an Ontario Arts Council Chalmers Arts Fellowship research grant in 2015 to work with Dr. Raymond Laflamme, former Director and now John von Neumann Chair in Quantum Information at IQC, to learn about Quantum Theory to inspire new works of art, meeting weekly at Perimeter Institute for Theoretical Physics (PI). De Decker lives in Waterloo, Ontario, Canada.

www.lauradedecker.com

Schwarz D Surface (2009)
by Bathsheba Grossman
Snap to grid version 25” x 25”
Originally 7500px square
Render in Maxwell

triply periodic
minimal surface
mathematics

math art
3D print
geometry

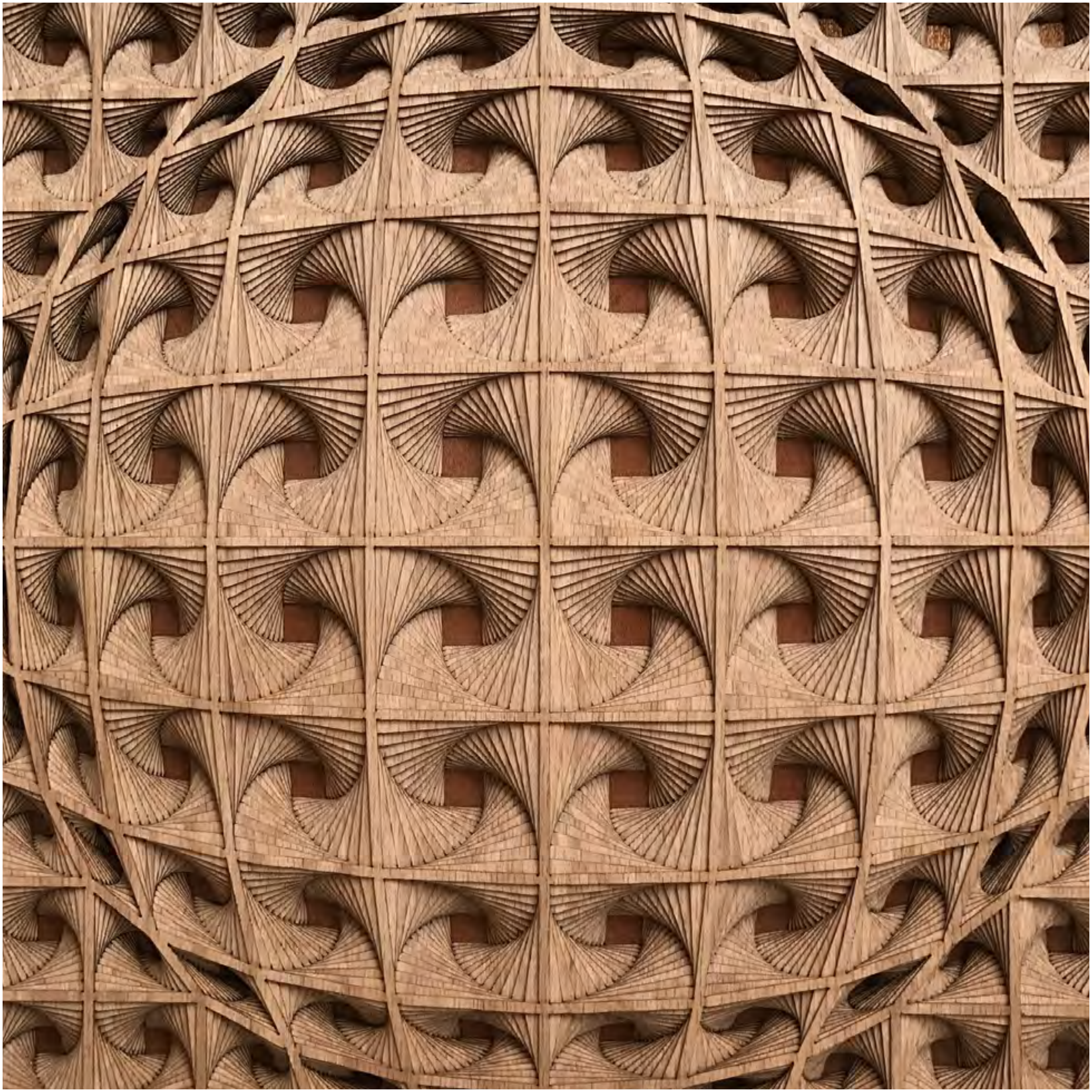
I started as a math major, and never saw a reason to escape that beginning: though I do less abstract and symbolic work now, my work remains deeply rooted in symmetry, knots, topology, and kindred subjects. I love the grace and beauty of geometry, and feel that I will always be learning new ways to exist in three (sometimes four) dimensions. Science is rather a separate subject but very much a continuing inspiration: in parallel with my geometrical pursuits I’ve always worked with scientists, as a programmer and now in data physicalization by way of 3D laser etched glass. I hope I always will: there’s no greater teacher than the natural world, and science is how we apprehend it.

This design is a straightforward derivation from a well-known minimal surface, the Schwarz D surface. (D is for diamond; Schwarz had others.) Minimal surfaces, speaking loosely, are ones with locally minimized surface area—the canonical examples are soap bubbles— and as a class they are mostly very beautiful. This one is a “triply periodic” minimal surface, meaning that it repeats itself in all three dimensions, and members of this subclass are generally not only gorgeous but also real brain-teasers: hard to wrap one’s intuition around, a challenge to visualize. Therefore we want to make models.

The base surface was computed in Surface Evolver, which is freeware for exploring minimal surfaces, and incidentally also a very good mesh conditioner. (Credit to Dr. Ken Brakke for this.) Importing to Rhinoceros, I peeled the surface into two layers, then added perforations to the mesh using a small Perl script which I wrote (today I would do this in Grasshopper, I think), and lastly installed small bridges to make it printable. Due to its heavy undercutting and fine detail it can be rendered only on a 3D printer with high resolution and without supports; among today’s technologies I recommend selective laser sintering as most suitable.

Bathsheba Grossman // Bathsheba Sculpture LLC.
Grossman is a sculptor in the medium of 3D printing and laser etched glass. Her path led through a math degree (Yale 1988), an art degree (University of Pennsylvania 1993), and various work as a scientific assistant, programmer, professor, printing service owner, and many more hats. She’s self-taught in CAD/CAM, and in the mid-1990’s began to work with 3D printing as a sculpture medium, pioneering both the manufacturing and the marketing sides of this technology. In 2001, she took her art business full-time, and since then has contributed works and designs to museums, TV shows, designer collections of lighting and jewelry, math and science research, coffee-table books, toy manufacturers, and many happy customers.

www.bathsheba.com



Exploding Outwards (2017)
by Colin Liotta
Snap to grid version 25” x 25”
Originally 12” x 12”
Layers of Red Oak and Maple

wood
layers

curves
tiling

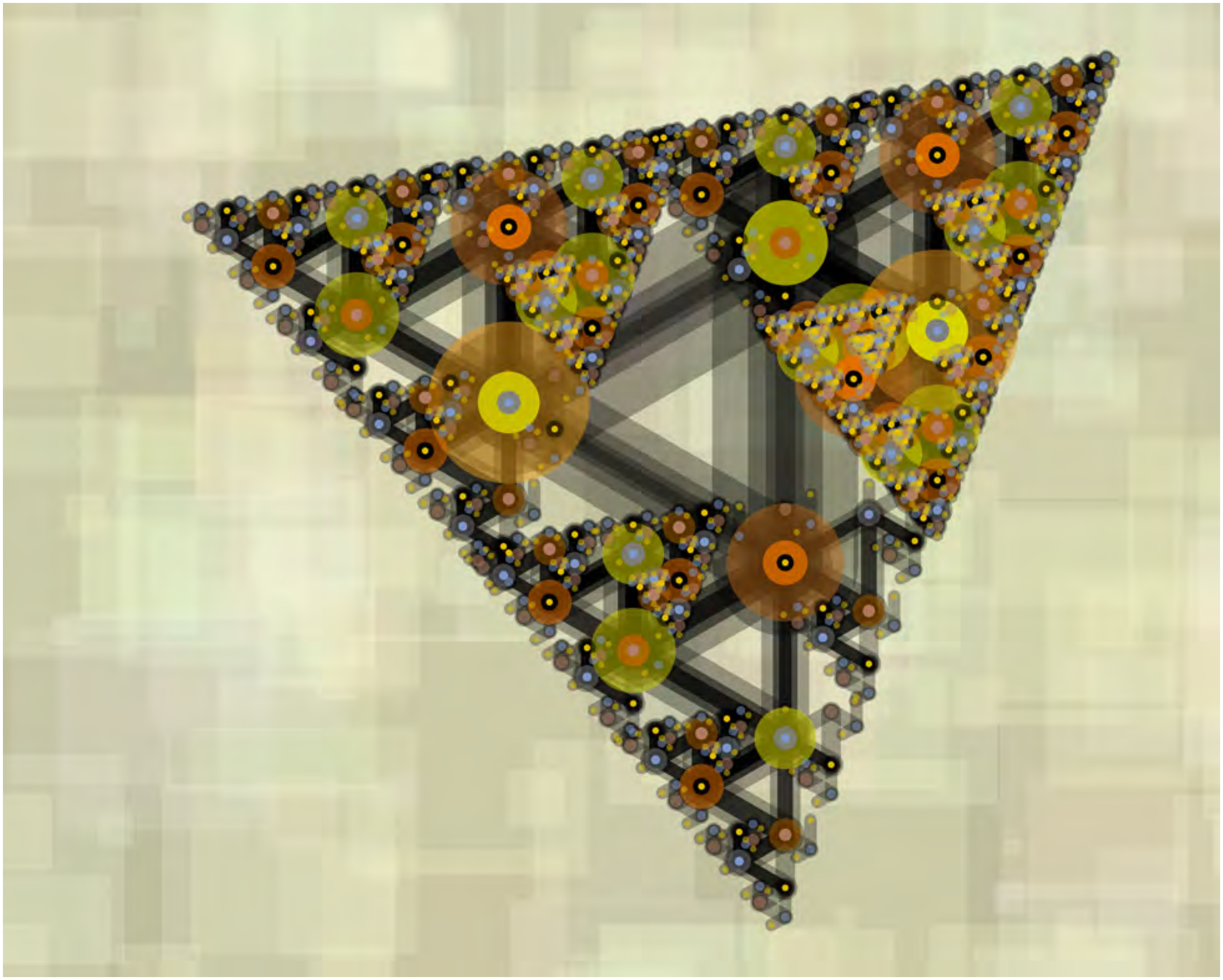
I’ve built a set of software tools that allows me to explore different mathematical concepts, and hopefully discover things that are surprising and/or beautiful along the way. Lately I’ve been playing around with tilings, tesselations, fractals, cellular automata, mazes, knots, folded polyhedra, and others. The laser cutter allows me to transform the designs that I discover into physical objects that can be manipulated and appreciated in a multisensorial way.

Since I was a young child, I have always been fascinated by the way that collections of straight lines can approximate curves. I was even more amazed that those curves could combine together to form flowing organic shapes. This pieces is composed of 16 layers. Each individual layer consists of nothing but straight line quadrilaterals that have been cut out of the material, there are no curves and no lines drawn on the material. Yet when all of the layers are stacked together you discover a mesmerizing pattern of intertwined curves and a large exploding sphere, simply in the way the different cut outs interact with each other.

In order to create a physical version of my design, I start with thin sheets of various hardwoods (maple, walnut, etc.). I precisely cut each sheet using a laser cutter to create relatively simple patterns that morph and change on each layer. Using alignment pins and a custom jig, I precisely stack and adhere all of the layers together. The simple patterns can then interact with each other to create complex organic forms.

Colin Liotta // Liotta Design. Liotta creates art that builds on his fascination with math and the way that simple 2D parts can create complex 3D wholes. His current pieces are made up of individual layers of laser cut paper or hardwood that are stacked together into intricate 3-dimensional patterns that are both organic and algorithmic. He writes his own software to explore different concepts and designs, mixing and matching different transformations until he serendipitously discovers something beautiful. He enjoys working with natural materials, feeling that there is something particularly delightful in the intersection of math and nature, chaos and order.

www.liottadesign.com



Sierpinski (2017)
by Vincent J. Matsko
Snap to grid version 25” x 25”
Originally 25 cm x 20 cm
Digital print

binary tree
Sierpinski triangle

Much of my work is based on two-dimensional geometry, such as Archimedean tilings of the plane, geometrical dissections, binary trees, random walks, mathematical envelopes, and fractals. I rely heavily on software environments like Mathematica and Processing to explore various geometrical forms. By parameterizing such forms, it is possible to explore, often interactively, hundreds of different possibilities. Once a pleasing form is found, color, texture, and other features are added, and then finessed to produce a final image.

This image is actually a binary tree. At each node, one branch is created by rotating 120 degrees and keeping the branch length the same. This results in recurrent visitations of the same nodes, indicated by overlapping transparent disks, and also produces the equilateral triangles in the image. The other branch is created by rotating 120 degrees in the opposite direction, but decreasing the branch length by the same ratio with each iteration. This results in the spiral elements in the image, as well as the tilt of the triangle. The branches are drawn in gray, becoming narrower and darker with each iteration of the algorithm.

This work was created using the software package Mathematica. I have been interested in exploring binary trees where the branching transformations result in the revisitation of nodes. For example, to revisit a node after three left branchings, a 120 degree rotation may be used while keeping the branch length the same. This leaves complete freedom in choosing the right branching transformation. I tried using a rotation for the right branches, since using two rotations produced interesting images in the past. Once I determined the parameters for drawing the branches and nodes, the plain background appeared too flat. As a result, I added overlaid, randomly generated rectangles to provide a texture contrasting the circular elements of the triangular image.

Vincent J. Matsko // University of San Francisco. Matsko currently teaches mathematics at the University of San Francisco. He teaches a Mathematics and Digital Art course, which is a mathematics class for non-majors. This is a laboratory-based course using the Processing environment designed to have students experience interactions among mathematics, programming, and art. Another of his abiding interests is the study of polyhedra; he is currently working on a book exploring how polyhedra are used in science, sculpture, and other art forms.

www.cre8math.com

Newton in Wackyland (2017)
by Kerry Mitchell
Snap to grid version 25” x 25”
Originally 16” x 16”
Digital print onto aluminum panel

fractal
Newton’s method
surreal
complex
rose curve
popcorn
cubic

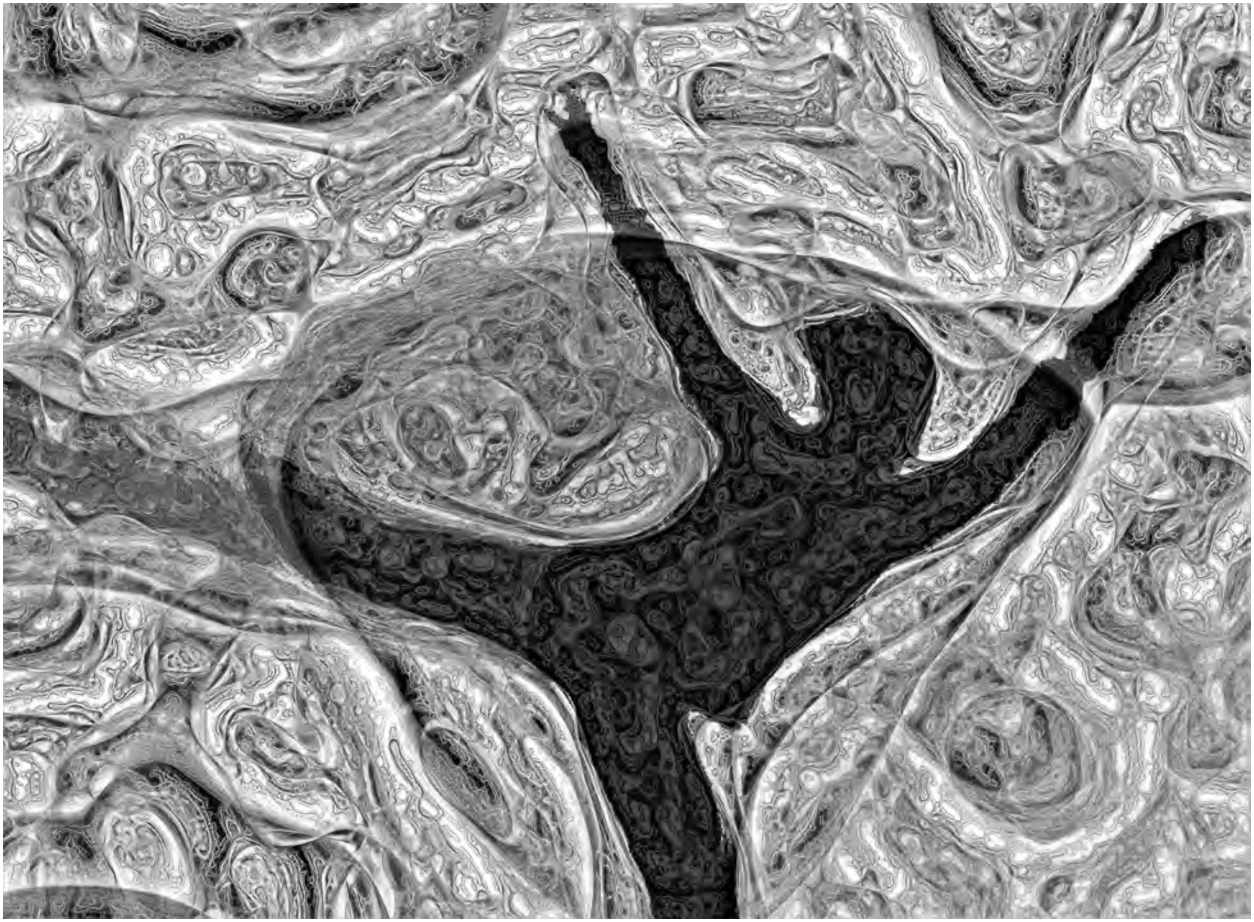
My work is composed primarily of computer generated, mathematically-inspired, abstract images. I draw from the areas of geometry, fractals, and numerical analysis, and combine them with image processing technology. The resulting images powerfully reflect the beauty of mathematics that is often obscured by dry formulae and analyses. An overriding theme that encompasses all of my work is the wondrous beauty and complexity that flows from a few, relatively simple, rules. Inherent in this process are feedback and connectivity; these are the elements that generate the patterns. They also demonstrate to me that mathematics is, in many cases, a metaphor for the beauty and complexity in life. This is what I try to capture.

This fractal represents using Newton’s method to solve the equation $z^3 - 1 = 0$ for complex-valued z. However, prior to solution, the complex plane was warped by 30 iterations of Pickover’s Popcorn algorithm. The image shows the orbit of z, relative to the rose curve r = 2 cos(3*theta) + 3 sin(2*theta). The results of the warping and the rose-curve coloring give the fractal a surreal look, reminiscent of a Dali landscape or the 1938 cartoon, “Porky in Wackyland.”

I created this work using the program Ultra Fractal. It is essentially a framework into which I enter my own formulas, one for the underlying fractal structure and one for the coloring of the pixels. Upon that, I applied a color palette and then rendered the image at high resolution for printing.

Kerry Mitchell // Mitchell was born in Iowa, where his father was an artist and an art teacher. From his mother, Kerry inherited his analytical skills, which served him well in his aerospace engineering studies at Purdue University (BSAAE 1984) and his later work at NASA. He began playing with fractals in 1985 after reading about the Mandelbrot set in a magazine. Once he saw how simple it was to generate the fractal, he was hooked. From there, he combined his mathematical and programming skills with his geometric aesthetic to create his artwork. His works have been featured on many bookcovers and calendars, and he has shown in several gallery and museum exhibitions.

www.kerrymitchellart.com



Turing-McCabe Pattern - Kinect - Experiment (2013)
by Janna Schimka, Rolf Schmuck, and Markus Schwehm
Snap to grid version 25” x 25”
Based on still image from video 600 x 440 pixel
Computer-Generated Video
Online viewing: www.ctemp1.exploratory-systems.de

Turing-McCabe pattern
reaction-diffusion system
motion capture
contemporary dance
electronic music
art performance

There is an argument by theoretical biologist Robert Rosen that it is in principle not possible to capture the essence of life with the currently available mathematics. Calculus was invented to describe celestial mechanics and not to describe living beings. Indeed, current mathematical models of living processes do not look very life-like with their rapid convergence to equilibria or periodic solutions. But if the limits of my (mathematical) language are the limits of my world, it is hard to peek beyond these limits. Is life just a complex mechanism or is there a fundamental difference between mechanisms and living organisms? We do not know – but pushing the limits in science and/or art may facilitate to advance our understanding of life.

Turing-McCabe patterns look very life-like. They resemble electron micrographs of living tissue. To fully appreciate the beauty of this pattern generation process, it is not sufficient to look at some still images as end-product of an otherwise invisible process. It is the pattern generation process itself and its ability to react to disturbances from the environment that is so exciting. To make this process visible and palpable to a broader audience, we wanted to create a system that is capable to generate Turing-McCabe patterns in high resolution and fast enough to be perceived as motion while still able to be manipulated interactively in real time. We used decent hardware and developed advanced algorithms to reach this goal.

Based on this idea we staged a series of performances during 2013/14 in Ludwigshafen, Germany. Our performances integrate the art forms dance, live electronic music, and interactive visuals in a continuous and unpredictable process. The movements of the dancer were captured by a Kinect and fed into the audio and visual pattern generation processes. Images were generated with 16 frames per second in HD and projected on a large screen. The three to four hour long performances took place in an abandoned shop, a city museum, an art, gallery and a museum of contemporary art. The image displayed in this exhibition is based upon a still image from an experimental video clip that we produced in preparation for these live performances.

Janna Schimka // Germany. Schimka was born in Austria and studied design, dance theatre, dance pedagogic, and contemporary dance in Vienna. She is an independent dancer, choreographer, performer, and runs a school for classical and contemporary dance in Mannheim, Germany.

Rolf Schmuck // Germany. Schmuck was born in Karlsruhe and studied communication sciences in Berlin, Germany. He is a multimedia designer, independent artist, and musician with a focus on electronic music. Together with Janna Schimka the artistic duo runs installations and performances under the name Orbit 3.1.

Markus Schwehm // Germany. Schwehm as born in Mannheim, studied mathematics, and received a PhD in computer science in Erlangen, Germany. He is a consultant in the field of mathematical modelling, simulation and visualisation and collaborated with Orbit 3.1 for several art performances.

www.orbit31.de
www.ctemp1.exploratory-systems.de

Curatorial Team

Tim Korb is the former Assistant Head in the Department of Computer Sciences at Purdue University, where he was responsible for a number of departmental programs, including the computing facilities, K-12 outreach, corporate and alumni relations, and undergraduate scholarships and awards. He has been involved in a number of faculty research projects, most recently in computer science education. Korb has been active in bringing art exhibits to the Lawson Computer Science Building and in encouraging students to explore the intersection of art and computer science.

Petronio Bendito is an Associate Professor of Visual Communications Design in the Patti and Rusty Rueff School of Visual and Performing Arts at Purdue University. He has served on the editorial board of *Media-N: Journal of the New Media Caucus*. Currently, he serves on the editorial board of the *Journal of Visual Literacy.* Bendito's primary research and creative endeavor interests include computational color design, color theory, algorithmic art, and visual literacy. In 2005, he co-curated the exhibition *Digital Concentrate: Art and Technology* for Purdue Galleries. He has exhibited his work nationally and internationally, including the *2014 Joint Mathematics Meetings Art Exhibition* and *Bridges Stockholm 2018 Art Exhibition*.

Acknowledgments

There are many people who have helped and inspired us to put this exhibit together. Dr. Sunil Prabhakar, Head of Computer Science, encouraged the creation of this exhibit—and provided funds from the Departmental Corporate Partners Program. Jean Jackson, the former manager of corporate relations for Computer Science, was a consistent advocate for public works of art to provide an inspirational setting. Marilyn Forsythe and Nan Fullerton have been both encouraging and generous in their support of art in the Lawson Building.

We thank Dr. Harry Bulow, Head of the Patti and Rusty Rueff School of Visual and Performing Arts, for his continued support for the integration of technology in the arts and interdisciplinary collaborations.

Finally, we thank the fifteen artists, scientists, and mathematicians who allowed us to display their inspiring works in this exhibition.

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