A Mathematical Art Exhibit at the 1065th AMS Meeting

The 1065th AMS Meeting was held at the University of Richmond, Virginia, which is a private liberal arts institution with approximately 4,000 undergraduate and graduate students in five schools. The campus consists of attractive red brick buildings in a collegiate gothic style set around shared open lawns that are connected by brick sidewalks. Westhampton Lake, at the center of the campus, completes the beauty of this university.

More than 250 mathematicians from around the world attended this meeting and presented their new findings through fifteen Special Sessions. *Mathematics and the Arts* was one of the sessions that was organized by Michael J. Field (who was also a conference keynote speaker) from the University of Houston, Gary Greenfield (who is the Editor of the Journal of Mathematics and the Arts, Taylor & Francis) from the host university, and Reza Sarhangi, the author, from Towson University, Maryland. Because of this session it was possible for the organizers to take one more step and organize a mathematical art exhibit for the duration of the conference. The mathematical art exhibit consisted of the artworks donated to the Bridges Organization by the artists that participated in past Bridges conferences. The Bridges Organization is a non-profit organization that oversees the annual international conference of *Bridges: Mathematical Connections in Art, Music, and Science* (www.BridgesMathArt.org). It was very nice of AMS and the conference organizers, especially Lester Caudill from the host university, to facilitate the existence of this exhibit.

The AMS Book Exhibit and Registration was located at the lobby of the Gottwald Science Center. A part of this lobby, which was separated from the rest by a few steps open to a raised curved area, was considered for the art exhibit. The exhibit began by a sculpture created by renown international sculptor Keizo Ushio from Japan. Keizo's mathematical artworks have been admired by the mathematicians and by the public around the world. He was one of the participants at the 2002 Bridges conference, which was held at Towson University, Maryland, USA.

Figure 1: *The start of the exhibit that welcomed the participants by Kiezo's marble Möbius.*

Figure 2: (L) *Keizo Ushio with one of his pieces*, (L) *One of Keizo' artwork that is carved from one solid piece of stone.*

Figure 3: (L) *Two 2D artworks by Michael Field*, (R) *The Close-up of the colored NeuralNet Quilt*

The first booth included two artworks of Michael Field. Field's artwork is mainly based on ideas coming from his research in dynamical systems, chaotic dynamics, and invariant measures. He develops all of the software, algorithms and coloring used for his art and builds the computers that generate the images. The colored *NeuralNet Quilt* in Figure 3.R shows part of a planar repeating pattern with symmetry *pgg* – no reflection symmetries at all (but many rotational and glide-reflection symmetries). Field has also worked on both bounded and repeating patterns with two-color symmetries where, using color, one can play a static symmetry. All of this becomes much more interesting when one works with two-color symmetries. Often, using color, one can play a static symmetry, such as *p4m*, against a dynamic symmetry like *p4*.

Figure 4: (L) *A Slide-Together Sculpture by Rinus Roelofs*, (R) *Two sculptures by Carlo H. Séquin.*

Figure 4.L shows one of slide-together sculptures made by well-known Dutch sculptor, Rinus Roelofs. In his paper published in the 2006 Bridges Proceedings he mentions: About ten years ago I discovered an interesting way to construct a tetrahedral shape by sliding together four rectangular planes in a certain way. By using halfway cuts in the planes it was possible to slide them together, all at once, to become the enclosed tetrahedron. This way of constructing objects and structures, finite and infinite, has been of my interest from then on.

Figure 4.R illustrates two of Carlo H. Séquin's sculptures (in the background there is a work by Anne Burns). The left artwork, "*Möbius Space*" (2000) a FDM black and silver painted, 4.2" diameter sculpture, was inspired by the toroidal Möbius sculptures of Keizo Ushio. But in this case the emphasis was shifted from the solid part to the missing space; the hollowed out space was greatly enlarged and enhanced with a luminous color, while the convex outer surface is painted black. The work on the right, "*Minimal Saddle Trefoil*" (1997), a 6" diameter bronze sculpture, was inspired by the wood sculptures of Brent Collins. The aim of this sculpture was to find out how tightly a ring of only three stories of a Scherk-Collins hole-saddle chain can be coiled. By introducing 540 degrees of twist and an azimuthal orientation of 45 degrees, this minimal-diameter configuration could be realized.

Carlo Séquin is a professor of Computer Science at the University of California, Berkeley. Séquin's works in computer graphics and in geometric design have provided a bridge to the world of art. In collaboration with a few sculptors of abstract geometric art, in particular with Brent Collins of Gower, MO, Séquin has found a new interest and yet another domain where the use of computer-aided tools can be explored and where new frontiers can be opened through the use of such tools. Large bronze sculptures resulting from collaboration between Brent Collins, Steve Reinmuth of the Bronze Studio in Eugene, OR, and Carlo Séquin have been installed in the Lobby of Sutardja Dai Hall at U.C. Berkeley and in the courtyard of the H&R Block headquarters building in Kansas City. Professor Séquin is a member of the Bridges Organization Board of Directors. He is in the leadership of the 2011 Bridges Conference that will be held in the University of Coimbra, Portugal.

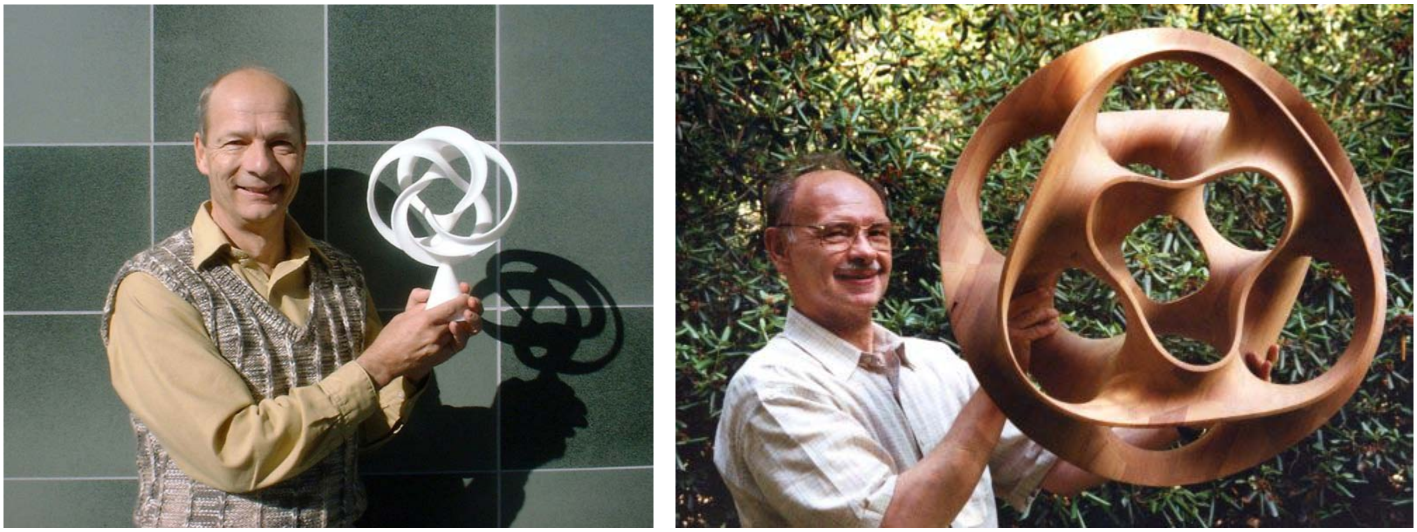


Figure 5: (L) *Carlo Séquin with one of his artwork,* (R) *The first joint sculpture built by sculptor Brent Collins from Carlo Séquin's computer blue prints.*

The next booth presented three artists/designers, Robert Fathauer (the Curator of the Bridges Art Exhibition and the co-editor of the Bridges Art Catalog), Junichi Yananose, and the author.

The artwork on the right corner of Figure 6.L (that is shown in details in Figure 6.R) is *Metaphor II* by Reza Sarhangi. This artwork is based on a metamorphosis (Figure 7.L) made from two different patterns that are presented in Figure 7.R.

Figure 6: (L) *The artworks of R. Fathauer, R. Sarhangi, and Junichi Yananose,* (R) *Metaphor II*

We note that the two top images in Figure 7.R present the relationships between a cross and an octagram. 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 in the tiling construction presented in the two bottom images in this figure is that the space between each four of them could be either a cross or octagram, depending on their arrangements.

In *Metaphor II* we see this metamorphosis in a new way when spirals are introduced to eliminate rigid lines and present a new harmony and balance as the dancing girl exhibited in the Sand Painting project in 2010 Bridges Conference (Figure 8).

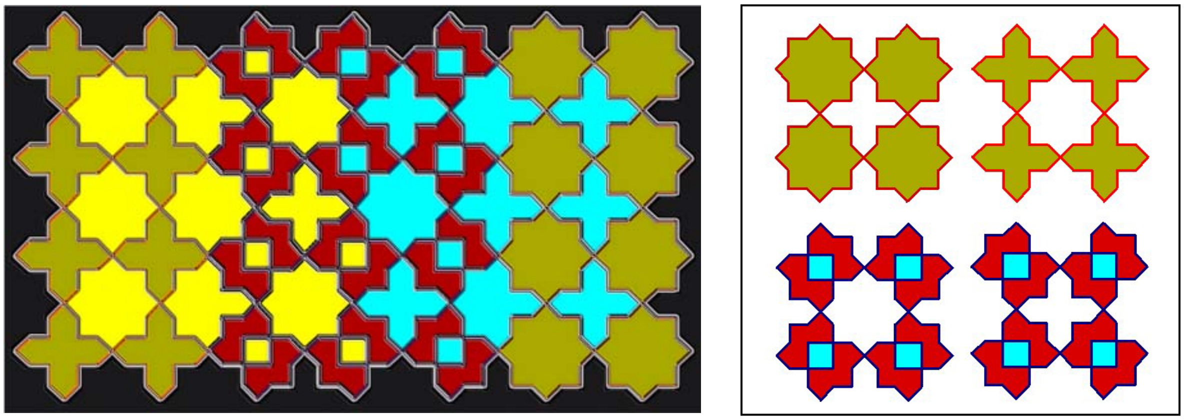


Figure 7: *Details of the artwork in Figure 6.*

Figure 8: *Two images from the sand painting on the floor of the old cathedral, before and after the destruction of the pattern by the dancing girl (a project by Elvira Wersche presented during the 2010 Bridges Conference, Pécs, Hungary). The sand used for the design is not colored. As Elvira explained the sand was collected in those colors from beaches and deserts all over the world.*

The curator of the Bridges Art Exhibition and the Joint Mathematics Meeting Art Exhibit, Robert Fathuaer, was presented in this art exhibit through two of his works: a hexagonal Fractal Tessellation, which was located at the center of the booth in Figure 6.L (also Figure 9.L), and another work done collaboratively with Reza Sarhangi, which was in the left corner of the same booth. Fathauer, who is the founder of the Tessellations Company, has a doctorate degree in Electrical Engineering from Cornell University and has been a research scientist at NASA's Jet Propulsion Laboratory and a research professor at Arizona State University, specializing in semiconductor materials and devices. He says: "Tessellations and fractals are possibly the two branches of mathematics with the greatest esthetic appeal. I am particularly interested in combining the two, a union that has only been touched on by other artists. Over time I have created numerous geometric fractal tessellations, and I have adapted some of these designs to lifelike tiles in the spirit of M.C. Escher. I have also created numerous non-fractal lifelike tessellations, and some of these are the basis for my puzzles."

The seven pointed star on the left corner of Figure 6.L is an artwork by Sarhangi and Fathauer to celebrate the legacy of the tenth century mathematician, Abul-Wafa-Buzjani. The work is based on a medieval approximation to the Regular Heptagon compass and straight-edge construction. This construction has been explained in the Buzjani's treatise, *On Those Parts of Geometry Needed by Craftsmen.* His construction is illustrated by the linework in the center portion of this artwork.

If the radius of the inscribed circle is 1, then one side of the heptagon constructed using his method will be $\sqrt{3}/2 \approx 0.8660$. The exact measure of one side of a heptagon with the radius of the inscribed circle equal to 1 is $2\mathit{Sin}\ \pi/7 \approx 0.8678$. That is the reason that even a modern software utility such as the Geometer's Sketchpad cannot pick up the error.

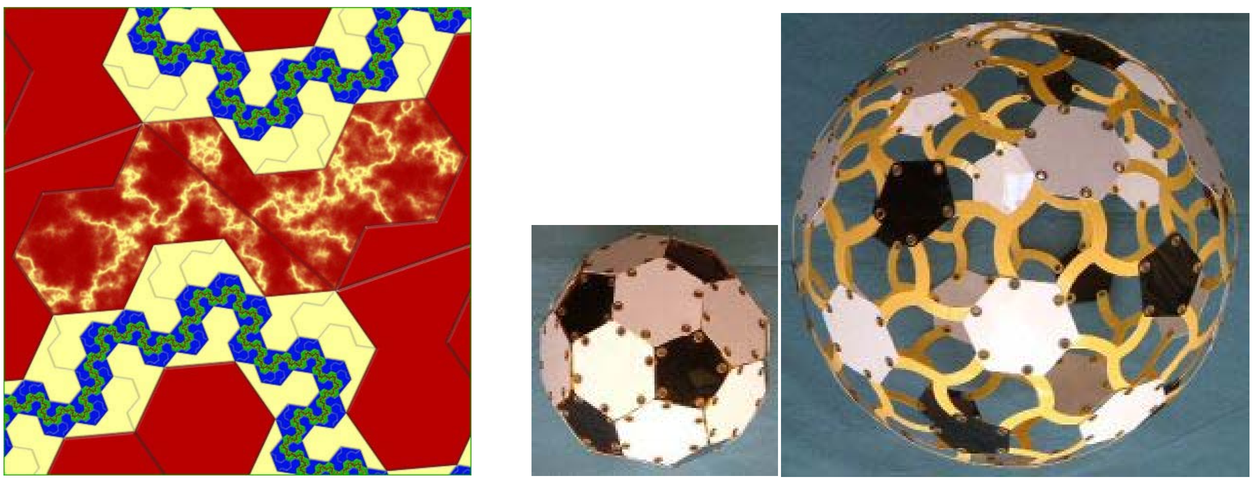


Figure 9: (L) *A Fractal Tessellation,* (R) *Juno's Truncated Icosahedron before and after expansion.*

On the same booth there were the 3D solids of Japanese designer Junichi Yananose, *Juno's Spinners* (Figure 6.L). Juno's spinners are polyhedron models that can be expanded and shrunken easily (Figure 9.R). A usual model of them consists of two elements. A rotational joint connects the end of each element, and the whole model transform together by a motion being transmitted through the joint. Rotational movement of an element changes the distance of each element.

Figure 10: (UL) *Gary Greenfield,* (UR) *Pheromone Ant Painting #21127, (LL) The works of Gary, Mehrdad, and Akio,* (LR) *The artworks of* Magnus Wenninger.

Figure 10 presents the next booth. We also see Gary Greenfield who is standing next to his artwork. The four artists presented on this booth are Gary Greenfield (the left corner of Figure 10.LL), Iranian artist Mehrdad Garousi (on the right corner of Figure 10.LR), Japanese artist Akio Hizume (the 3D starts on Figure 10.LL), and Magnus Wenninger (Figure 10.LR).

Gary's "*Pheromone Ant Painting #21127*", as he describes it, is an agent based, computer generated art work. A swarm of 500 virtual ants is initially deposited in two clusters on a gray 600 x 600 toridal grid. On the basis of pheromones that are produced by grid cells, and pheromones that are produced by the ants, during their wanderings the ants first develop a black and white underpainting and then, by making short brush stokes, overpaint in two colors. This painting (along with another one presented in the 2006 Bridges Art Exhibition) reveals structure, organization, harmony, complexity, and gives some illusion of depth. The goal of this work is to study biologically based models and behavioral rule sets that initiate aesthetic processes. Thus artist becomes meta-artist in the effort to harness the computational capabilities of swarms of agents for artistic purposes.

The Dome by Merhdad Garousi is an artwork that he believes it presents the way that Islamic tessellation appears in the interior architecture of domes of the mosques. Here the very small basic rectangular and triangular mosaics make hexagonal and six pointed star flowers, all of which match side by side and create an infinite seamless texture with a nice self similarity at the center. Notice that the color of the mosaics in the image are like the real mosaics' main colors of the domes, like orange, lemon, amethyst, blue, pink and grass green. A similar artwork of this artist appeared on the cover of MAA Focus.

Akio Hizume (the artist of *Star Gates* in Figure 10.LL) says: I don't separate science and art. Both of them are human Arts. I have made architectural sculpture, city design, graphics, music, scientific research, etc. Every work is based on the common mathematical structure. The difference is just dimension of space.

Magnus Wenninger was born in 1919. He was ordinate a Roman Catholic priest in 1945. He earned graduate degrees in philosophy and mathematics education, taught mathematics and chaired the Mathematics Department at St. Augustine's College in Nassau, the Bahamas. Magnus began publishing articles about polyhedral in the early 1960's, and his first book, *Polyhedron Models for the Classroom*, was published in 1966. Since then he has published three more books and many articles. His publications and his models have been a source of inspiration for many model designers, mathematicians, and artists around the world. Mangus says: Only after I myself made these 3D models of 4D polytopes did I come to better understand what is involved in the statement that these models are 3D "picture" of 4D objects. Thus making models is helpful in the learning process.

Figure 11: *Magnus Wenninger in his studio*

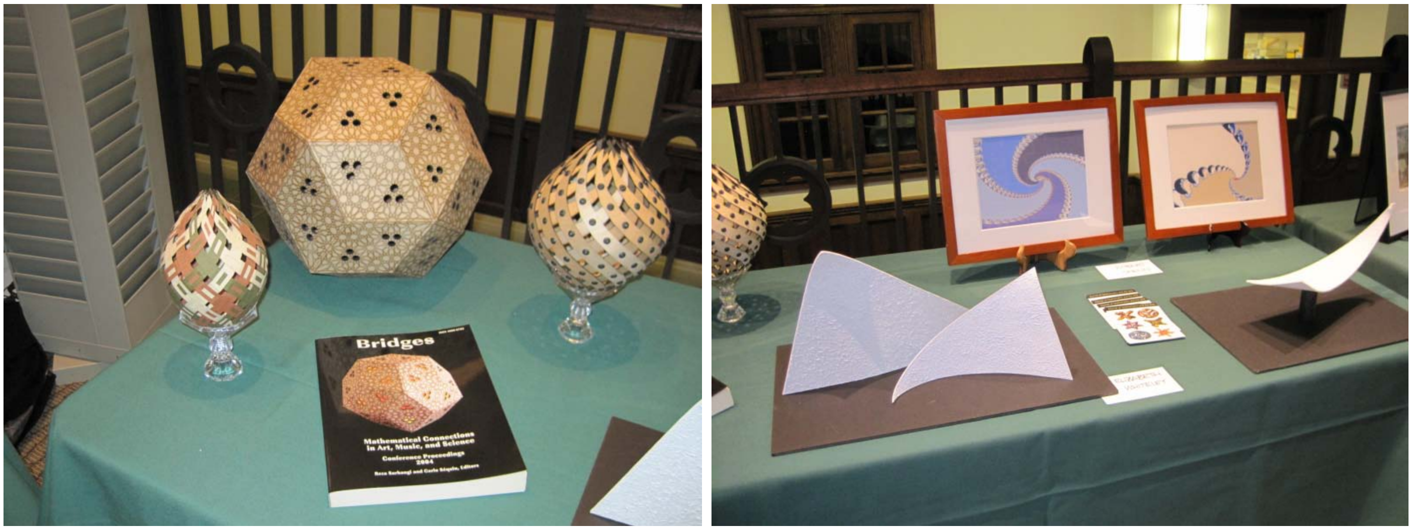


Figure 12: (L) *Three artworks by Chris Palmer*, (R) *The art of Robert Spann and Elizabeth Whiteley*.

The rhombi-icontahedron in Figure 12.L appeared on the front cover of the 2004 Bridges Conference Proceedings. It is ornamented with an original composition using a traditional tile set laser engraved onto wood. The pattern consists of rings of twelve pointed stars that would be on an equilateral triangular grid when tessellated on a plane. The pattern is slightly distorted to fit on the rhombic faces and the stars make rings of ten when the polyhedron is assembled. Ornamented polyhedra have been a subject of interest to Chris K. Palmer for many years.

Palmer, Shadowfolds, is one of the most creative origami artists in the west. He has been a keynote speaker, art exhibition contributor, and author in many Bridge conferences.

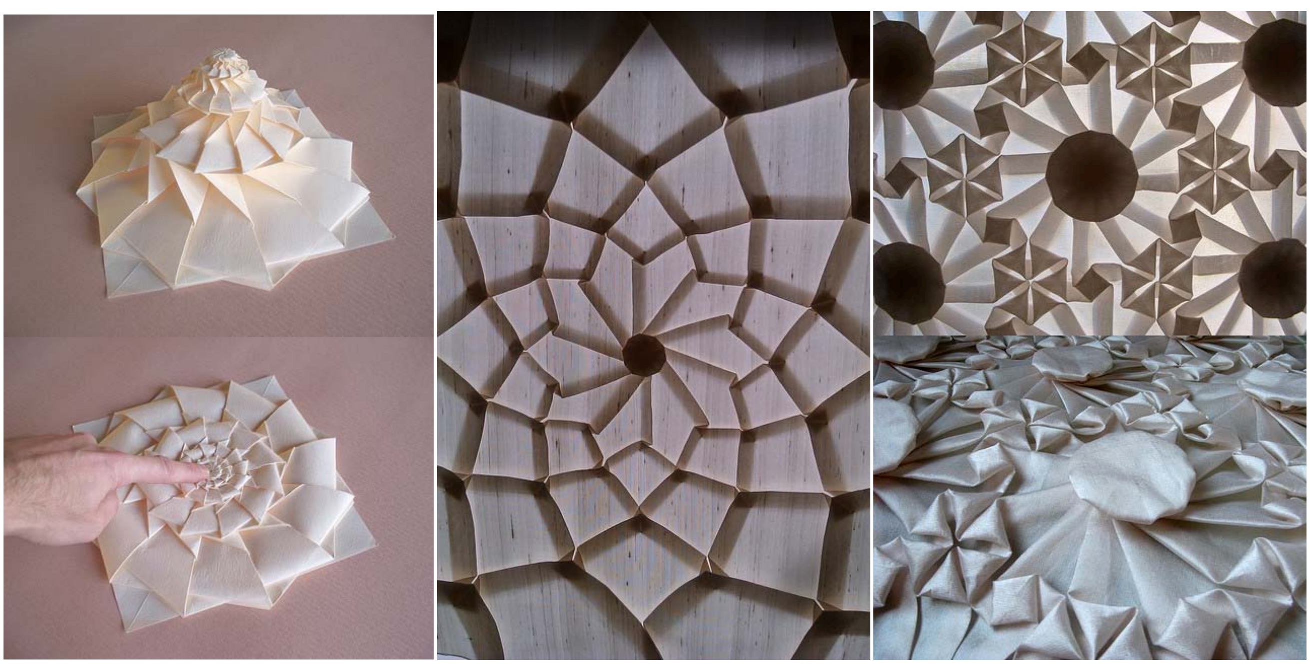


Figure 13: *Chris Palmer's artworks.*

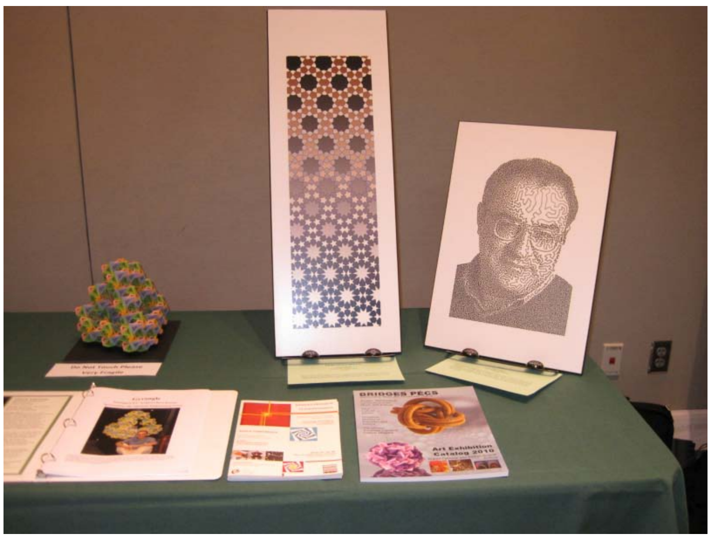
Figure 12.R exhibits two artists, Robert Spann on the back and Elizabeth Whiteley in front.

Newton's method is one of the most widely used methods for finding roots of non linear equations. Numerous authors have also applied the Newton iteration function, or Newton Map, to functions of a complex variable to obtain images. Robert Spann extends that body of work to polynomials with complex exponents. He says: I obtain images by iterating the Newton Map of complex polynomials such as $Z^{\omega} - \rho = 0$ where Z is a complex variable, ρ a complex number, $\omega = n + mi$, n and m are integers. Complex integer exponents, instead of real integer exponents, changes the Newton Map and hence the images that are obtained.

Elizabeth Whiteley is a painter and sculptor living in Washington DC. She participated in this art exhibit with two of her *geometry curve triangles.* She says: I paint and make sculpture to express my delight in seeking visual relationships and finding new connections within simple geometric shapes. The discovery of harmony and symmetry leads to peace of mind. When I complete an artwork, I have a sense that there is, indeed, order and beauty in this seemingly chaotic world.

Elizabeth has attended Bridges Conferences at Towson University and in London. She exhibited her folding screens in the Bridges London 2006 Art Exhibition.

The next booth exhibited the works of three artists: Craig Kaplan, George Hart, and Robert Bosch.



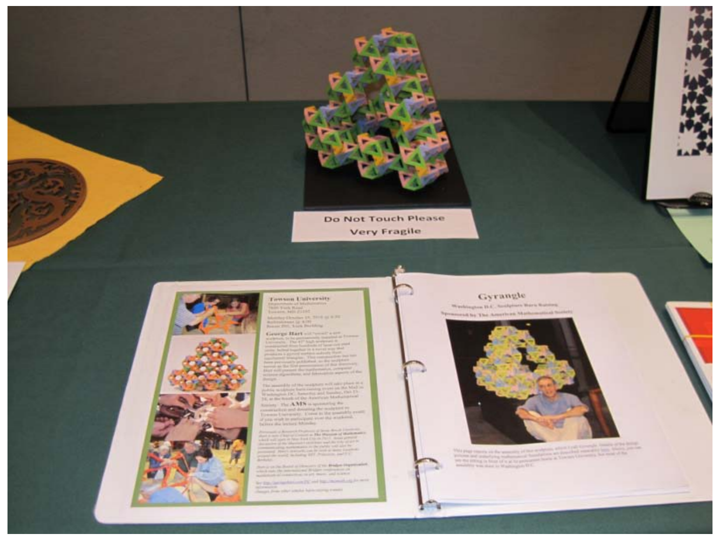


Figure 14: (UL) *Craig Kaplan's artworks*, (UR) *The Rapid Prototype model of the Gyrangle*, (LL) *A photograph from the Gyrangle barn-raising at the Mall*,(LR) *Gyrangle and George Hart at Towson University, Maryland*.

Craig S. Kaplan, a computer science professor at the University of Waterloo, Canada, has produced a growing number of works of art and design, both alone and in collaboration. The main focus of Kaplan's research is on the relationships between computer graphics, art, and design, with an emphasis on applications to graphic design, illustration, and architecture. He explores the mathematical theories of symmetry and tilings as a means of creating patterns, as well as the perceptual basis for our aesthetic appreciation of those patterns. Craig's contribution to this exhibit consisted of two works: *Leo* and *An Islamic Parquet Deformation*.

Leo is the portrait of Leo Khachiyan, a computer scientist whose research is linked to the history of the Traveling Salesman Problem. The portrait was created by scattering a collection of sample points over the portrait, where sampling density was controlled by the darkness of the underlying image. The sample points were then fed as cities to a heuristic TSP solver, which produced the near- optimal tour drawn in the portrait.

Islamic Metamorphosis #2 is a smooth metamorphosis between two well-known Islamic star patterns. The original star patterns are both based on a tiling by regular decagons and irregular bow-tie-shaped hexagons. They lie in a continuum of patterns derivable from that tiling using a single, real-valued parameter.

Kaplan is a member of the Board of Directors of the Bridges Organization, and chaired the 2009 Bridges Conference held at the Banff International Research Station in Alberta, Canada.

The sculptor, mathematician and computer scientist George Hart was presented at the exhibit through a rapid prototype laser print model of one of his artworks, the *Gyrangle*. During the National Science and Engineering Festival (October 23-24) at the National Mall, Washington DC, he led a public sculpture barn-raising of *Gyrangle*, at the AMS booth. The 38" high sculpture consists of hundreds of laser-cut steel units bolted together in a novel way. To be exact, there are 490 flat or folded hollow equilateral triangles in four colors. It illustrates a discrete version of the gyroid surface, made entirely from equilateral triangles.

The gyroid is a smooth, infinite, triply periodic, minimal surface discovered by Alan Schoen in 1970. Hart discovered a way to triangulate it entirely with equilateral triangles. His construction is “uniform on the faces” and “uniform on the vertices.” Although the gyroid itself contains no straight lines, Hart’s triangular discretization contains infinite straight lines embedded in various directions. It divides all space into two congruent, but mirror-image volumes. Another interesting property is that the faces do not meet edge-to-edge, but instead each triangle shares six half-edges with six neighboring triangles. The construction is previously unpublished, so the sculpture serves as the first presentation of this discovery.

The AMS commissioned the construction of this artwork and donated it to the Department of Mathematics at Towson University, Maryland. The sculpture is now at the lobby of the department. A complete report about the Gyrangle has been published on the AMS online.

George Hart is Chief of Content at The Museum of Mathematics, which will open in New York City in 2012. As a sculptor, Hart’s work is recognized around the world for its mathematical depth and creative use of materials. He is a pioneer in using computer technology and solid freeform fabrication in the design and fabrication of sculpture. Examples of his artwork can be seen at major universities, such as M.I.T., U.C. Berkeley, and Princeton University. George is a member of the Board of Directors of the Bridges Organization, and chaired the 2010 Bridges Conference held at the 2010 European Capital Cultural City of Pecs, Hungary.

Figure 15: (L) *Two artworks by Robert*, (R) *A close-up of Embrace.*

Robert (Bob) Bosch, a professor of mathematics at Oberlin College, Ohio, presented two pieces at the meeting: "*Embrace*", a two-piece 6-inch-diameter sculpture made out of stainless steel and brass, and "Sphere and Spiral", a 3-inch-diameter hand-carved ball of maple.

Bob believes all artists are optimizers: “All artists try to perform a task—creating a piece of artwork—at the highest level possible. The main difference between me and other artists is that I use optimization explicitly. I don't use a pencil, paintbrush, or any other traditional tool. I do use a computer, but not in the same way that other digital artists do. Instead, I use mathematical optimization. Here's how I work: After I get an idea for a piece, I translate the idea into a mathematical optimization problem. I then solve the problem, render the solution, and see if I'm pleased with the result. If I am, I stop. If not, I revise the mathematical optimization problem, solve it, render its solution, and examine it. Often, I need to go through many iterations to end up with a piece that pleases me. I do this out of a love of mathematical optimization—the theory, the algorithms, the numerous applications."

Embrace was first shown at the 2010 JMM, San Francisco. The jurors of the Mathematics Art Exhibition Prize, which was established through an endowment provided to the AMS, awarded Embrace First Prize. Bob writes, "I began by converting a drawing of a two-component link into a symmetric collection of points. By treating the points as the cities of a Traveling Salesman Problem and adding constraints that forced the salesman's tour to be symmetric, I constructed a symmetric simple-closed curve that divides the plane into two pieces: inside and outside. With a water jet cutter, I cut along this Jordan curve through quarter-inch thick, six-inch diameter disks of steel and brass. By swapping inside pieces I obtained two copies of the sculpture. Here, steel is inside and brass is outside."

The last table exhibited the works of four artists: Anne Burns, John Sullivan, Robert Krawczyk, and Nathanial Freidman.

Figure 16: (L) *Robert Krawczyk' Mandela and John Sullivan's Optiverse*, (R) *Anne Burns' fractal arts and Nat Freidman's "Spiral Möbius"*.

Krawczyk is an architecture professor at the Illinois Institute of Technology, Chicago.   He has participated in the Bridges Art Exhibition for many years. One of his designs was selected for the official logo of the 2005 Bridges Conference "Renaissance Banff Conference", Canada. Later this design became the official logo of the Banff International Research Station: Mathematical Innovation and Discovery. He is the author of a book, *The Code writing Workbook: Creating Computational Architecture in AutoLISP* (Princeton Architectural Press).

The exhibited mandala by Krawczyk is based on the simple geometric definition of "mandala"; from the Sanskirt for circle. A mandala is a complex circular design intended to draw the eye inward to its center having symmetrical and radial balance. These mandalas are constructed by computing individual points along Fermat's Spiral at a constant radial angle. The seeds placed along this type of spiral have the same pattern as found in daises, sunflowers, pineapples, and pine cones.

Krawczyk has developed the computer programs for creating his mandalas. He says: “By layering a series of spirals, mirrored around the horizontal and vertical axis, a secondary set of patterns begins to emerge. Even a slight variation in the placement angle generates a great variety of unexpected patterns. The final enhancement is the shape and rendering of the seed itself”.

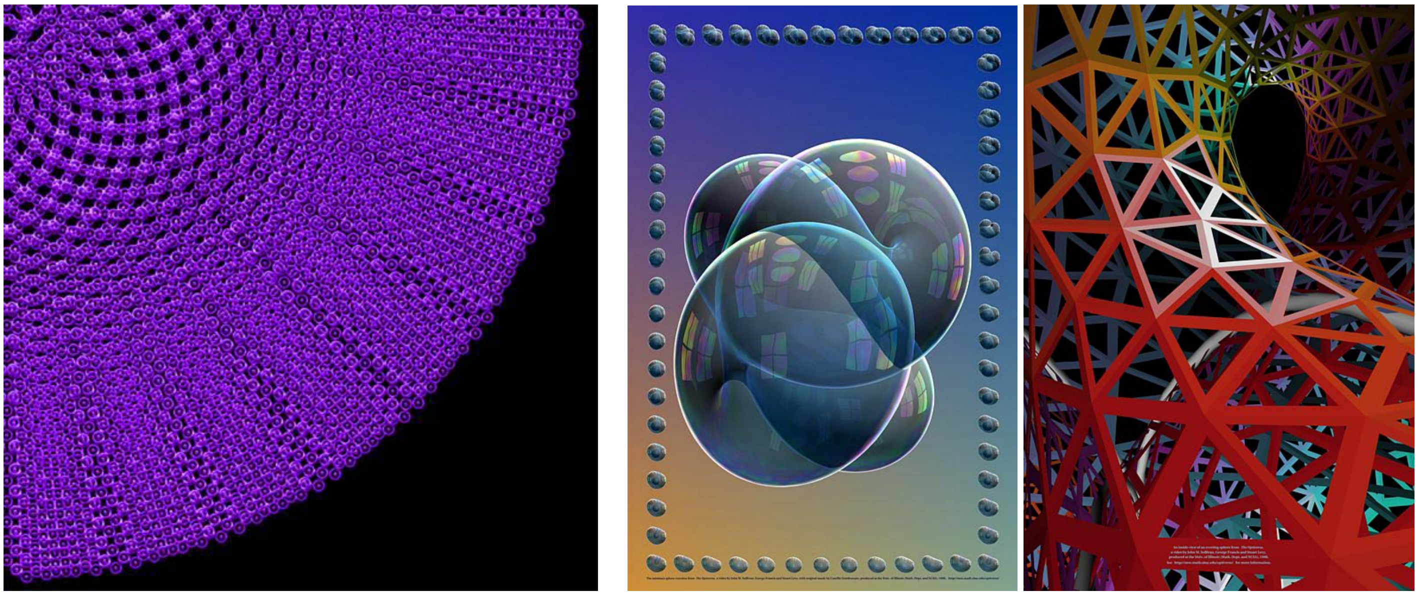


Figure 17: (L) *The details of Krawczyk’s artwork, "Fermat's Spiral Mandala 011.0",* (R) *“Optiverse: Minimax Sphere Eversion” and another related image “An inside view of an everting sphere from The Optiverse” are the still images of a video by John M. Sullivan, George Francis, Stuart Levy, produced at the Univ. of Illinois, Math. Dept. and NCSA, 1998.*

John M. Sullivan is Professor of Mathematical Visualization at the Technische Universität Berlin. After earlier degrees from Harvard and Cambridge, he received his Ph.D. in Mathematics from Princeton in 1990. The mathematical beauty of the optimal curves and surfaces he studies often translates into artistic beauty. His mathematical artworks — computer-generated prints, sculptures and videos — have been exhibited in eight US states and seven European countries.

A still image of “*The Optiverse*” was the artwork of Sullivan on the exhibit. John says: It was a surprising consequence of an abstract mathematical theorem of Steve Smale that a spherical surface can be turned inside out without tearing or creasing, if we do allow the surface to pass through itself. We have computed a family of sphere eversions which have rotational symmetry of different orders and are computed automatically by minimizing an elastic bending energy for surfaces in space. We start with a complicated self-intersecting sphere, which has the desired rotational symmetry, and is also halfway inside-out in the sense of having its inside and outside equally exposed. This halfway model is a saddle critical point for the Willmore energy. When we push off the saddle in two opposite directions and then flow downhill in energy to the ordinary round sphere, it is inside-out in one direction, but not in the other. "The Optiverse", premiered at ICM 1998, shows the first few eversions in our family, with 2-, 3-, 4-, and 5-fold symmetry.

Nat Friedman is a professor emeritus at the University at Albany-SUNY. He is the founder of The International Society of the Arts, Mathematics, and Architecture (ISAMA). Nat says: " On a whim, in 1971 I took an adulteducation course in sculpture and discovered I loved carving wood and stone and have been an avid sculptor ever since. I started out making sculptures with spaces due to the influence of Barbara Hepworth and Henry Moore. About fifteen years ago I started making form-space sculpture by breaking granite, removing pieces to create space, and then using epoxy to join the remaining pieces back together. Random fractal geometry is introduced by the fracturing of the granite. Although I tap the stone with a chisel along a straight line, the stone does not always break along a straight line. Usually mathematical sculpture is not about the human psyche but rather about beautiful forms or complicated fractal designs."

Nat was strictly a carver of wood and stone but discovered the advantage of clay for sculpting Möbius bands and knots when taking a ceramics class in 2003."

Figure 18: *A close-up of "Spiral Möbius"shown in Figure 16.*

Figure 18 presents a close-up of *"Spiral Möbius"*. This sculpture was made by starting with a cut circular band of clay and then bending and twisting before rejoining the cut ends. Props were used to preserve the shape while drying. The form was then sanded, low fired, sanded, and then high fired.

Nat is a juror for the Bridges Art Exhibition and the JMM and is the organizer of many mathematical art conferences in the US and around the world.

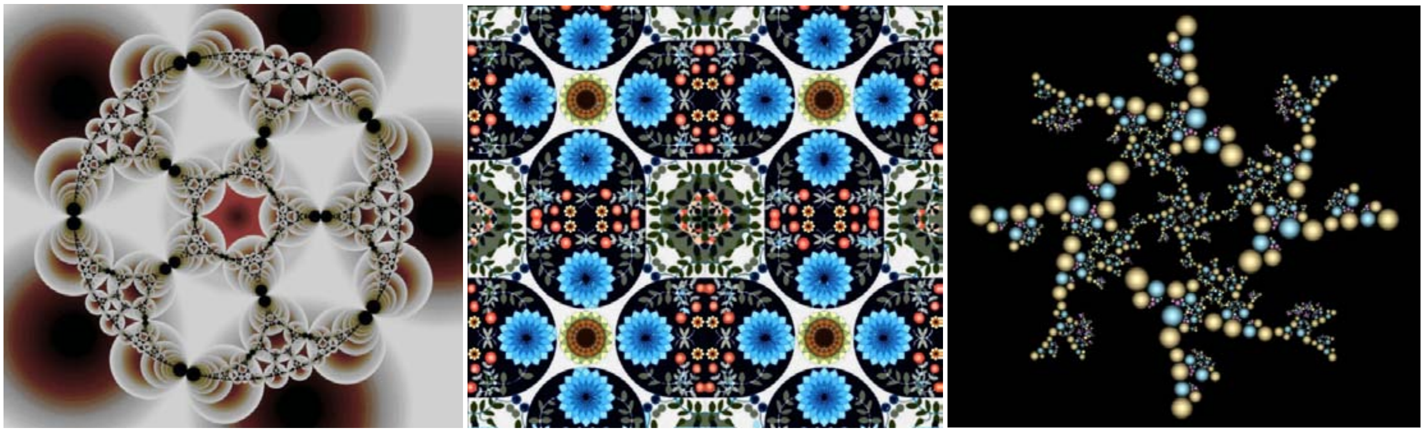


Figure 19: (L) "*Circle Inversions*", (M) "*Tile Design*" (R) "*Iterated Möbius Transformations*".

Anne Burns is a professor of mathematics at Long Island University, Brookville, New York. Anne began her studies as an art major. Years later she took a course in College Algebra, loved it, and just kept going until she received a Ph.D. in Mathematics from SUNY at Stony Brook. Her research and publications are in the areas of Dynamical Systems and Computer Graphics. She spends her free time combining her love of nature, mathematics and art. She says: "I am a very visual person; before I became a mathematician I was a painter. When I prove something in mathematics I must first convince myself of its truth with a visual argument. Computers make it possible to "see" the beauty of mathematics. I love the logic of programming and using the computer to translate functions and relations into aesthetically pleasing patterns and pictures.

Anne, who is one of the organizers of the Bridges Art Exhibition and the JMM Art Exhibit, says about her artworks: "The thread that ties together my computer artwork is the mathematical concept of recursion. Recursion is a technique in computer programming that can be used to implement replacement rules. In nature replacement rules abound. A single cell contains all the instructions for the cell to split; then the resulting cells split and so on. The branching of trees, the compounding of inflorescences, phyllotaxis, formation of clouds, terrains and mountains are all examples of a simple rule applied over and over again. In the mathematical technique of recursion a function calls itself two or more times; each time it creates multiple copies of itself. I enjoy using recursion to imitate nature in fractal mathscapes. I also enjoy creating abstract forms. Nature may suggest the rules, but the artist can abstract them and create attractive patterns resembling Persian rugs, quilts and other geometric designs. "

Figure 19 shows three artworks by Anne Burns. Figure 19.R will appear on the cover of the January issue of the College Mathematics Journal (January issue). Another work of Anne, *"Imaginary Garden"* appeared on the cover of 2007 Bridges Proceedings.

Figure 20: (UL) *Beautiful and Delicious reptiles,* (UR) *Doug Dunham, Robert Bosch, and Carolyn A. Yackel, the reptile baker* (LL) *Tom Banchoff picking a reptile and Nathan Selikoff is waiting for one,* (LR*) Lynn Bodner from Monmouth University, New Jersey, is presenting "Reconstructing Bourgoin's 14-Pointed Star Polygon Designs".*

The exhibit started parallel with the Mathematics and the Arts Special Session at 8:00 am on Saturday, and ended together on Sunday afternoon at 5:00 pm. The session began with a talk by Rachel Wells Hall**,** Saint Joseph's University, Pennsylvania, in mathematical music theory. An interesting event was when Carolyn Yackel from Mercer University, Georgia, invited people to taste her reptile cookies after she ended her talk "*Counting and Illustrating Rep-Tiles*". A highlight of the session was a presentation by the former MAA President and a mathematics professor at Brown University, Tom Banchoff. His talk included his memories of his meetings with the famous surrealist artist Salvador Dali.

The visual arts presented during the talks were outstanding and perhaps it is an impossible task to capture all the images in one exhibit. So we consider this exhibit, and similarly all other mathematical art exhibits, as a few rain drops, that even though does not satisfy our thirst, gives us the sense of what water is.

Reza Sarhangi