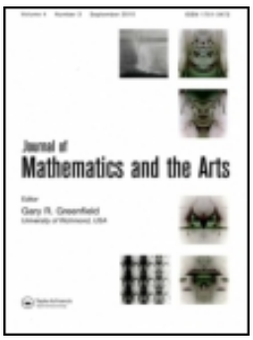

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REPORT

Knotting Mathematics and Art:
Conference in Low Dimensional Topology and Mathematical Art, University of South Florida, Tampa, FL, 1–4 November 2007

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The mutual influence between mathematics and art has a history that goes back to the earliest human-made decorations and is now studied at the scholarly level. This can be observed through an increasing number of interdisciplinary conferences connecting mathematics and art. *Knotting Mathematics and Art: Conference on Low Dimensional Topology and Mathematical Art*, which took place at the University of South Florida (USF) from 1 to 4 November 2007, was a stimulating event with over 60 invited and contributed presentations and three companion art exhibits. There were over 100 participants. It was a unique conference focused on a specific area of mathematical research, knot theory and topology, and on mathematical art influenced by this area of mathematics. With no prejudice intended to the many excellent knot-theory talks, it is the art-related aspects of the conference that are the focus of this report in this journal.

The conference opened with an energetic lecture by John Conway, which also served as the USF's annual Nagle Lecture. In a full hall with over 200 people, Conway presented an orbifold approach to understanding two-dimensional symmetry groups. The approach was extracted from his soon-to-be-released book, *The Symmetry of Things*, co-authored with Heidi Burgiel and Chaim Goodman-Strauss. Large artistic prints produced by Chaim Goodman-Strauss were covering the walls around the lecture hall and served as illustrations of the two-dimensional wallpaper groups. Conway described each of the groups using a lucid notation to distinguish rotations (red) from reflections (blue) and illustrated its action through the artwork surrounding the attendees. On the last day of the conference, Conway also delivered the final plenary lecture of the conference. He described a way to mentally organize the three-dimensional crystallographic groups, focusing on the 35 interesting prime groups and the subgroup lattice they form. Again, the lecture was greatly enriched with beautiful images by Chaim Goodman-Strauss.

A number of invited plenary lectures highlighted various maths/art connections and experiences. The regular conference started with Ivars Peterson surveying the wide range of contemporary mathematical art, touching on Möbius strips, minimal surfaces, knots, hyperbolic spaces, higher dimensions and fractals. His lecture also served as an introduction to the artists present at the conference and those artists whose artwork was exhibited at the accompanied exhibition. Thomas Banchoff described some of the mathematical aspects of Salvatore Dali's work, especially his use of the four-dimensional hypercube. Banchoff recounted delightful stories of his meetings with Dali over ten years, discussing hypercubes and geometric models. His talk was reinforced with excerpts from the documentary movie *Dali's Dimensions*. Brent Collins and Carlo Sequin reported on their 12-year collaboration designing sculpture based on towers of saddle surfaces. Sequin writes geometric design software and Collins works by hand carving wood, resulting in intricate forms that are ultimately cast in bronze. It was exciting to learn how Collins' intuition brought him to beautiful shapes of surfaces and knots without any prior knowledge of topology. However, the most complex pieces were produced in collaboration with Sequin who was able to use computer programs to

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prototype the pieces. J. Scott Carter and Tony Robbin spoke of their collaborations, Carter's excitement over three-dimensional projections of four-dimensional objects, and Robbin's emotional experience of perceiving a higher dimensional space through his paintings of overlapping geometric images.

Several presentations that focused on research in knot theory also had an aesthetic component, but only those that focused on intentionally produced art are mentioned below. The talks ranged from 'nano-sculptures', through macro structures, digital prints, dance and music. Nadrian C. Seeman's work in DNA nanotechnology includes building complex three-dimensional DNA structures, e.g. cubes, truncated octahedra and knots, which can be interpreted as artistic sculptures at the nano level. Bringing sculpture to the macro level, Carlo Sequin presented techniques for designing and building puzzling sculptures consisting of knots interlinked in various configurations, such as 20 trefoils arranged as the faces of an icosahedron, each being linked with three of its neighbours. Physical models of knotted structures made by rapid prototyping machines were passed around the audience for a hands-on appreciation. Chiam Goodman-Strauss gave a survey of the computational tools and techniques he uses to generate eye-catching illustrations. His talk was also accompanied with hands-on material. He passed out mathematical image trading cards, and provided laser-cut wooden puzzle pieces for the audience to assemble into a pentagram fractal. He also provided information about his weekly 'Math Factor' radio show on puzzles, symmetry, math and art. Alex Feingold explained his techniques for solid metal sculptures representing topological structures and also passed around bronze models of knots and topological surfaces. Karl Schaffer described his mathematical dance company and showed videos of dances based on ideas of combinatorics or symmetry. Alissa Crans explained how certain relations between major and minor triads could be understood as dihedral group actions on a toroidal lattice. Val Pinciu proved new upper bounds on the number of nets into which certain convex polyhedra can be dissected, relating this to a centuries-old representational technique first used by the German renaissance artist, Albrecht Dürer.

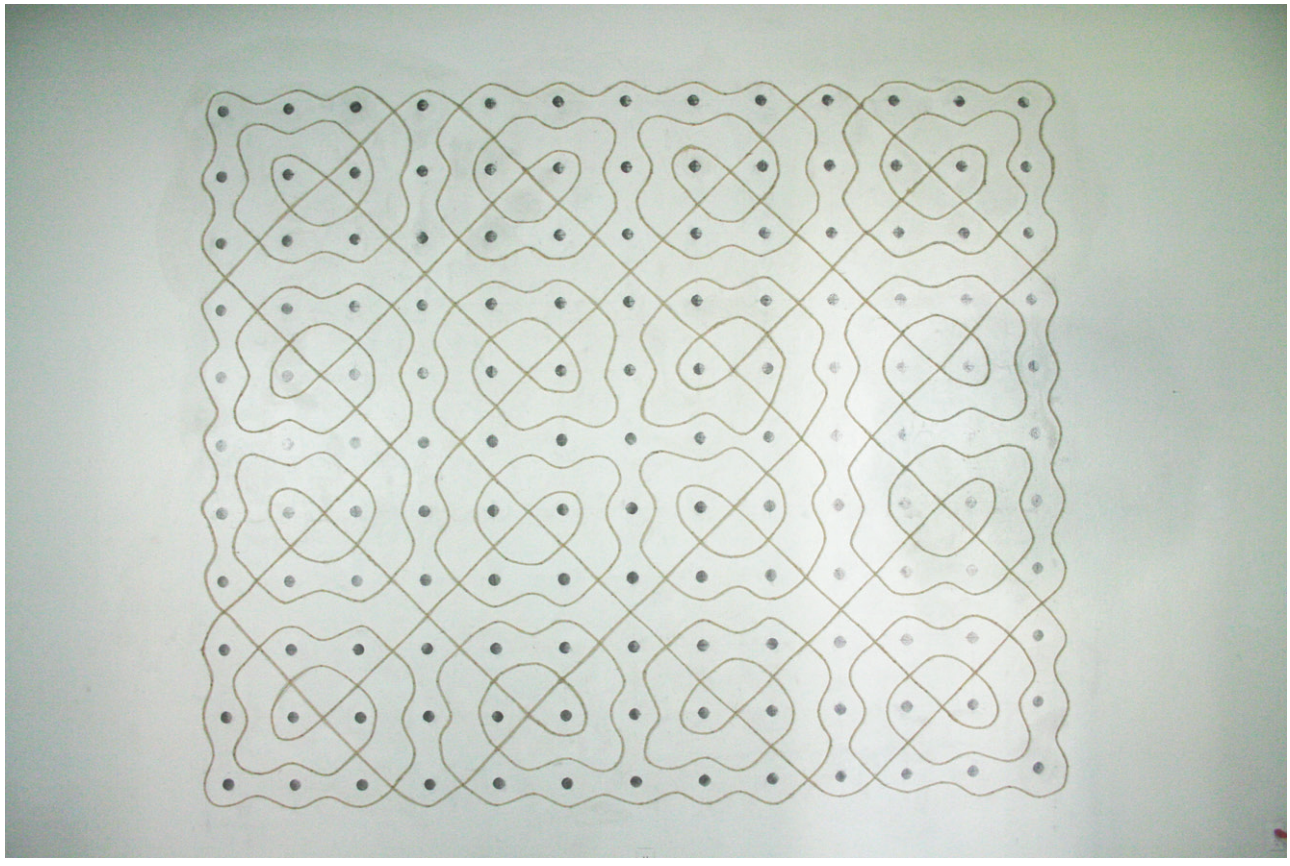

Figure 1. 'Mirror Curve Celtic Knot', Paulus Gerdes, rope and graphite on wall, approx. 12 feet by 12 feet, realized by John Sims et al. Photograph © Ronald Pehmoeller. Reprinted with permission.

Radmila Sazdanovic showed colourful images of hyperbolic tessellations generated by a Mathematica software package that she co-authored. George W. Hart showed examples of his geometric sculpture and tried to convey the beauty of the truncated 120-cell.

A companion art exhibition, 'Rhythm of Structure: Beyond the Mathematics', was curated by John Sims, who gave gallery talks introducing the artworks. The art was presented in three venues, two galleries at the USF campus and the Museum of Science and Industry at Tampa. The Oliver Gallery at USF contained four large wall pieces, each roughly 12 feet square. A wall drawing by Sol Lewit provided a visual lesson in combinatorics, showing 'All Combinations of Arcs from Four Corners and Straight Lines from Four Directions'. A textile relief by Paulus Gerdes (Figure 1) employs hundreds of feet of rope to physically draw your eye along a sinuous symmetric cycle. A wall drawing by Sims, '$3^2+4^2=5^2$: Five Ways', uses visual groupings to let you see this sum in new ways. Another piece by John Sims presented a catalogue made in heavy rope of the 28 1-tangles with up to eight crossings.

It is rare to see a sizable amount of mathematical sculpture assembled in one exhibit, so it was a treat to visit the Center Gallery at the Marshal Center at the USF campus, which featured 14 mathematical sculptures. This included six bronzes by Helaman Ferguson (see Figure 2), three bronzes by Charles Perry, and two mahogany pieces by Brent Collins (see Figure 3). In addition, there was a rapid prototyping sculpture by Bathsheba Grossman, a granite piece by Nat Friedman, and a bronze knot by Alex Feingold. The digital prints on the walls were by Tony Robbin and John Sims. A virtual maths-art museum is planned to be added at the conference website providing photographs and details of each individual work.

Across the street from the USF campus, the Tampa Museum of Science and Industry exhibited a series of

Figure 2. Bronze sculptures by Helaman Ferguson: 'Figure Eight Knot Compliment VI', 'Regular Homotopy Equivalent Links', 'Costa Five and Cuneiform Hyperbolic Disk', and 'Torus with Cross-cap I'. Photograph © Alex Feingold. Reprinted with permission.

Figure 3. 'Trefoil', Brent Collins, mahogany, 24 inches. Photograph © Natasha Jonoska. Reprinted with permission. See insert for colour version of this figure.

digital prints including work by Davide Cervone, Mike Field, Chaim Goodman-Strauss, Gary Greenfield, Slavik Jablan and Radmila Sazdanovic. A six-foot diameter projection of the truncated 120-cell was displayed under the dinosaurs in the museum lobby. It had been assembled on site by a group of USF Math Club students under the direction of George Hart as a pre-conference activity. The opening reception at MOSI featured the curator's lecture of John Sims. The venue was decorated by Sims' quilt based on the decimal expansion of π. Sims also introduced a performance of his 12-bar blues style musical composition, *Blue Pi*, based on digits of the base seven expansion of π.

A third aspect of the conference, beyond the talks and art exhibits, was led by a group from Eastern Michigan University. It consisted of a series of discussions and interviews on 'What is the Mathematics that Artists Use and Need?' A panel discussion soliciting opinions about this topic with panellists Brent Collins, Karl Schaeffer, Charles Perry, and Sasho Kalajdzievski raised several issues about the mathematical instruction difficulties and challenges facing the art students. This is part of the curriculum

foundations project sponsored by the Mathematics Association of America, the National Science Foundation, and Eastern Michigan University. The findings will be published by MAA as part of the series *Voices from Other Disciplines*.

The primary conference organizers at USF were Masahico Saito and Natasha Jonoska. John Sims curated the exhibits. And many others also helped with the local arrangements. Together they created an event that brought together a synergetic mix of art and mathematics professionals for four days of rich interaction. A programme and photos, including events omitted here, can be found at the conference website (http://knotart.cas.usf.edu/).