The 2008 Bridges Conference was held in the Dutch city of Leeuwarden, better known to the mathematical world as the birthplace of M. C. Escher (1898-1972). The conference venue hosted an ambitious art exhibit featuring over a hundred works by seventy artists and representing at least a dozen countries. There were seven additional solo artist shows at village churches. According to conference organizer Reza Sarhangi, the 2008 show was the largest exhibit of mathematical art anywhere in the world. Participation exceeded both the 2006 and 2007 shows by more than fifty percent. Although mathematical scientists still outnumber professional artists in Bridges shows, the 2008 exhibit was notable in attracting a good number of professional artists (about a third of the total). Robert Fathauer, Ann Burns, and Nat Friedman deserve special commendation for curating the exhibit.

The works on display may be roughly divided into four categories, with many pieces representing more than one category: direct visualization of abstract mathematical objects, art generated by mathematical algorithms, art employing scientific techniques such as colour theory and unusual perspective, and figurative art with mathematical themes. Much of Escher’s work belongs to the last category. Media included digital prints and machine drawing; pencil, watercolour, oils, acrylics, lithograph, and etching; photographs; various plastics and polymers; bronze, steel, alabaster, wood, leather, fabric, glass, beads, and folded paper; and more exotic material such as rope, pipe cleaners, paper napkins, and lentils. In this report, I discuss a few of the pieces that particularly struck me with their aesthetic beauty and mathematical depth. Apart from any individual work, the sheer variety of the show was impressive. I have attempted to
choose pieces that convey the range of media used and the chief mathematical themes. However, many outstanding pieces have been omitted from this report. I recommend viewing the entire exhibit online at http://www.bridgesmathart.org/art-exhibits/bridges2008/

Escher had a profound influence on mathematical art, and his legacy was in great evidence here. Although a professional artist with no formal mathematical training, Escher succeeded in communicating the substance of complicated and sometimes cutting-edge mathematics. In particular, he was fascinated by tilings, polytopes, recursion, unusual perspective, and visual paradoxes—all of which were well represented at the Bridges show. The Hungarian artist and animated filmmaker István Orosz’s etchings are particularly reminiscent of Escher. Orosz’s visual paradox The Wall (Figure 1) explores territory similar to that of Escher’s impossible structure, Belvedere (lithograph, 1958). In other exhibited works, Orosz employs anamorphosis (distorted perspective; these pieces are meant to be viewed with a cylindrical mirror or at an oblique angle). A few of his etchings appeared at the main exhibition, but the bulk of his work, including an animated film, was shown at the village church in Jorwert. Another artist, Dick Termes, uses six-point perspective on spheres (Gargoyles of St. Denis, Figure 2) in a way that is evocative of Escher’s Hand with Reflecting Sphere (1935). Although Termes works with actual three-dimensional spheres and Escher used perspective to depict the reflection of a room in a spherical mirror, both artists explore this unusual perspective. I particularly enjoy Termes’ gargoyles, which remind me of Escher’s mythical beasts.

One of the primary goals of the Bridges conference is to foster collaboration between artists and mathematical scientists. In the true Bridges spirit, the Welsh sculptor Benjamin Storch collaborated the mathematicians Bernd Krauskopf and Hinke Osinga to produce Manifold (Figure 3). A crocheted model of the Lorenz manifold appearing in the 2006 Bridges art exhibit fascinated Storch, who had been developing a special hammering technique for producing sheets of metal with negative curvature. Krauskopf and Osinga developed computer models from which Storch worked.

Bridges has always had a strong contingent of sculptors, including both professional artists and mathematical scientists. This year was no exception. Bridges participants were treated to a solo
show by Bridges regular (and conference organizer) Rinus Roelofs, a Dutch sculptor whose work depicts complicated mathematical forms. He develops sculptures on a computer before creating them in a wide variety of media. Roelofs’ stunning new steel sculpture was on display outside of the village church of Boers (Figure 4). The piece is actually one continuous surface that interweaves with itself. Roelofs has developed a series of pieces using this “connected holes” construction (see his web site http://www.rinusroelofs.nl for more examples). Another mathematical sculptor (and dentist), Karel Vreeburg, created the alabaster Hidden Split Torus 540 (Figure 5) that demonstrates a striking contrast between the rough natural rock and the smooth mathematical form within.

Colour theory is another intersection of science and art. James Mai’s digital print Circuitous (Blue) (Figure 6) uses “colour-interactive palettes” to demonstrate how contrast between colours affects our perception—although the continuous band is always the same grey, it interacts differently with each of the background colours.

Since Escher’s time, computers have profoundly influenced how artists create mathematical art. In Helios [var. 1198505515] (Figure 7), Nathan Selikoff uses iterated functions to plot the typical behaviour of a strange attractor. Computer artists Robert Bosch, Robert Fathauer, and Andrew Pike’s Escher Fish Portrait combines an Escher-inspired fish tiling with overall shading to create a portrait of Escher (Figure 8). They used computer algorithms to ensure that no two fish that touch are the same shade of grey. Other mathematicians, computer scientists, and artists used three-dimensional printing to translate mathematical equations directly into sculpture. (These “printers” create three-dimensional models from computer specifications.) For example, Peter Jansen created his polyamide Lobster (Figure 9) from a chaotic flow equation using a three-dimensional printer.

Although Escher depicted constructions in the forefront of pure mathematics (Coxeter’s 1997 article “The trigonometry of hyperbolic tessellations” proved that Escher perfectly executed hyperbolic tilings of the Poincaré disk in the 1950s), most artwork at Bridges does not represent cutting-edge mathematics. Edmund Harriss’ art is unusual in that it illustrates his own research in aperiodic tilings and discrete geometry. The two substitution tilings that make up Nautilus
and Conch (Figure 10) depicts a breakthrough made by Harriss, Pierre Arnoux, Maki Furukado and Shunji Ito in the study of Rauzy fractals (see their article “Algebraic numbers and group automorphisms,” preprint, 2007).

On Saturday of the conference, Bridges participants took a bus tour of the surrounding villages, where seven ancient churches held additional exhibits, including those of Roelofs and Orosz. Each church presented one artist. The church of Bears (Figure 11) hosted work of Oscar Reutersvärd (1915-2002), a Swedish artist who preceded Escher and was interested in visual paradoxes. Reutersvärd clearly deserves to be better known in the mathematical art world. In contrast to Escher’s, his figures depict abstract mathematical forms, sparse, yet deliberate.

This year’s art show and the continuing tradition of Bridges attest to the profound inspiration that artists and mathematical scientists take from each other’s work. Bridges has shown once again that these two communities have much in common; when they intersect, both become richer. The legacy of M.C. Escher lives on.
Figure 1. István Orosz, The Wall (etching, 2005).

Figure 2. Dick A. Termes, Gargoyles of St. Denis (permanent pen and acrylics on a polyethylene globe, 30.5 cm diameter, 2005).
Figure 3. Benjamin Storch, *Manifold* (8 cm wide closed band of stainless steel on oak base, 75 × 75 × 45 cm, 2007). Four views of the sculpture, which Storch constructed in collaboration with the mathematicians Bernd Krauskopf and Hinke Osinga.
Figure 4. Bridges participants view an outdoor sculpture by Rinus Roelofs demonstrating his “connected holes” construction (corten steel, 4 × 2.5 m, 2008). The sculpture forms one continuous surface.
Figure 5. Karel Vreeburg, *Hidden Split Torus 540* (alabaster, 67 cm × 44 cm × 24 cm, 2007).

Figure 6. James Mai, *Circuitous (Blue)* (digital print, 41 × 41 cm, 2006). (See insert for a colour image of this work.)
Figure 7. Nathan Selikoff, *Helios [var. 1198505515]* (lightjet print, 61 cm × 61 cm, 2007; www.nathanselikoff.com)
Figure 8. Robert Bosch, Robert Fathauer, and Andrew Pike, *Escher Fish Portrait* (digital print, 61 × 80 cm, 2008).
Figure 9.  Peter Jansen, *Lobster* (polyamide sculpture produced by a 3d printer, 14 cm × 20 cm × 8 cm, 2007; www.strangeattractors.eu)

Figure 10.  Edmund Harriss, *Nautilus and Conch* (laser-cut wooden tiles, fits within a 30.5 cm square, 2006).
Figure 11. Conference participants view an exhibit of “impossible figures” by Oscar Reutersvärd (1915-2002) in the village church of Bear.