MAA Golden Section Mathematical Art Exhibition 2019

"Cohesion"

30 cm tall

Bronze with patina

2002

This sculpture is one of many shapes produced by the "Sculpture Generator I" program, which takes a finite number of "stories" from the central area of Scherk's "Second Minimal Surface" and bends that saddle/tunnel chain into a toroidal loop. Here there are just two monkey saddles in a strongly twisted loop with skinny connections between them. It was fabricated on a 3D-printer and then converted into bronze by Steve Reinmuth using an investment casting process.

MAA Golden Section Mathematical Art Exhibition 2019

"Totem"

30 cm tall

Bronze with patina

2007

This sculpture also came out of the "Sculpture Generator I" program, which takes a finite number of "stories" from the central area of Scherk's "Second Minimal Surface" and bends that saddle/tunnel chain into a toroidal loop. Here there are four monkey saddles in a lightly twisted loop. The loop has then been stretched in the vertical direction to acquire a totem shape. It was fabricated on a 3D-printer and then converted into bronze by Steve Reinmuth using an investment casting process.

MAA Golden Section Mathematical Art Exhibition 2019

"Whirled White Web"

300 x 300 x 350 cm

Snowsculpture, Breckenridge, CO, (2003)

12 x 12 x 15 cm

Eurographics Award, bronze (since 2008)

The monkey-saddle trefoil shape, inspired by Brent Collins' "Hyperbolic Hexagon," was carved in snow at the Snowsculpting Championships in Breckenridge, CO, in January of 2003. In 2008 it was adopted by the annual Eurographics Conference as a trophy for the "Young Researcher Award", the "Technical Achievement Award," and for the "Distinguished Career Award."

MAA Golden Section Mathematical Art Exhibition 2019

"Dodecahedral Volution"

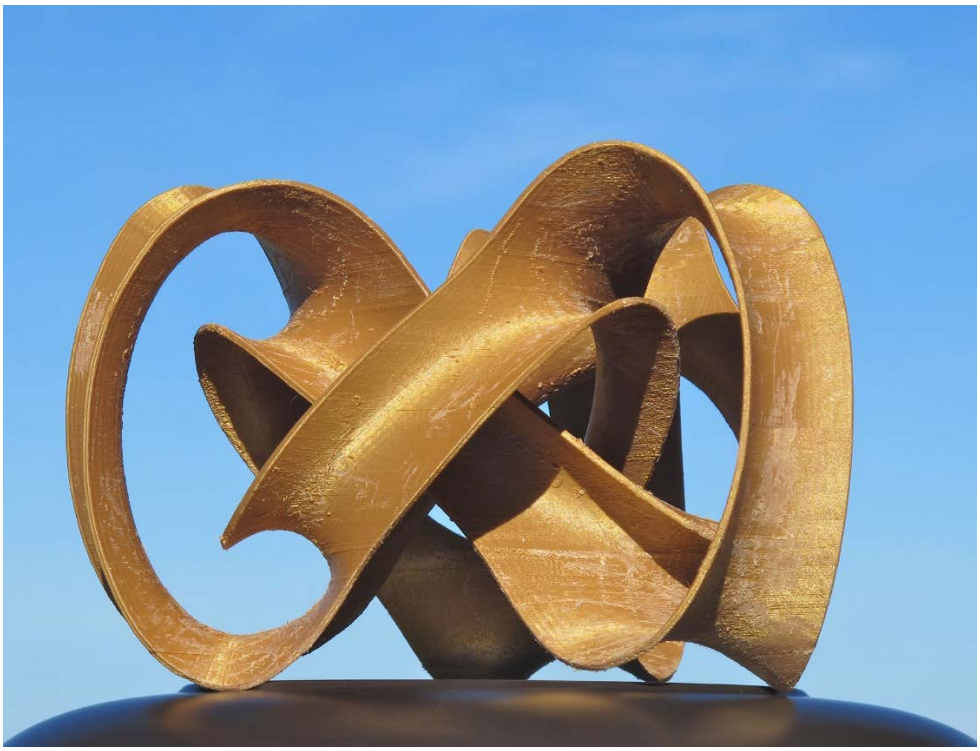
12 x 12 x 12 cm

Bronze with patina

2007

The border of this sculpture is a Hamiltonian path on the edges of a regular dodecahedron. This border suspends a minimal surface with two internal tunnels. It has been modeled with Kan Brakke's "Surface Evolver" program. This would not be a stable configuration in nature, because of the two side-by-side tunnels. But in computer modeling we can maintain perfect symmetry, which prevents one tunnel collapsing while the other one grows in size. This shape was fabricated on a 3D-printer and then converted into bronze by Steve Reinmuth using an investment casting process.

MAA Golden Section Mathematical Art Exhibition 2019



“Curly Utility Trefoil”

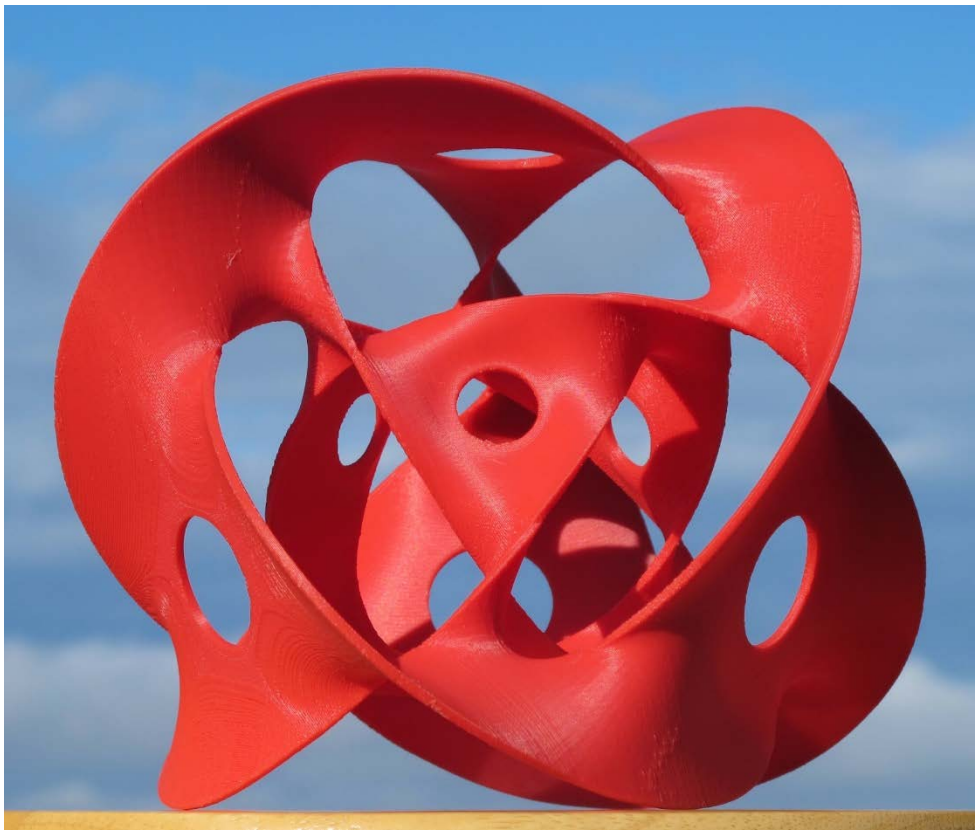
14 x 21 x 18 cm

3D-print, PLA plastic

2018

This is the result of my attempt to make a sculpture in the style of Charles O. Perry that is based on the simplest non-planar graph: the "Utility Graph," also known as the bipartite graph K_3,3. I found a nice symmetrical way to embed this graph in 3D Euclidean space, by starting with a simple trefoil knot and adding three cross-connecting struts at the points where the typical depiction of this knot would show three crossings. A curled cross section, which is found in many of Perry’s ribbon sculptures, is swept along the trefoil curve. The cross-connecting struts form the type of loopy T-intersections with this ribbon, which are also prominent features in Perry's “Continuum” in Washington, DC.

MAA Golden Section Mathematical Art Exhibition 2019



“Two-Level Borromean Soap Film, Suspended by Six Circles”

19 x 19 x 19 cm

ABS, 3D-print

2018

I start with the simplest Borromean soap film surface and place a smaller copy inside so that they just touch. To obtain a proper border configuration for a 2-manifold, I transform the six areas where two ovals touch into skewed crossing of two smooth curves. This results in a border curve system consisting of six simple interlinked loops. I force these loops to be perfectly circular, and then construct a soap-film on this border structure. To enhance the transparency of this sculpture and allow a better look at the inside geometry, I also cut out eight small circular holes from the two sets of 3-sided face patches in the outer and inner levels of the soap film. The 2-manifold is single-sided, of genus 6, and has 6+8 punctures.

MAA Golden Section Mathematical Art Exhibition 2019

“3-Level Borromean Soap Film, Bordered by 3 Intertwined Torus Knots”

22 x 22 x 22 cm

ABS: 3D-print

2018

Here I am placing three of the simple Borromean soap film surfaces inside one another. Again, I want to turn this into a single 2-manifold surface with a cohesive, smooth border curve structure. In this case, when the 12 touch-points of the 9 scaled ovals are turned into skewed crossings of smooth curves, the three ovals that were lying in the same plane readily turn into a single simple knot. This is either a Figure-8 knot or a (2,3)-Torus knot, depending on the choice of subsequent over- and under-passes. The torus knot will lead to smoother border curves, since it requires less undulations in the 3rd dimension than the alternating Figure-8 knot. The resulting single-sided 2-manifold has 3+12 borders and is of genus 9.

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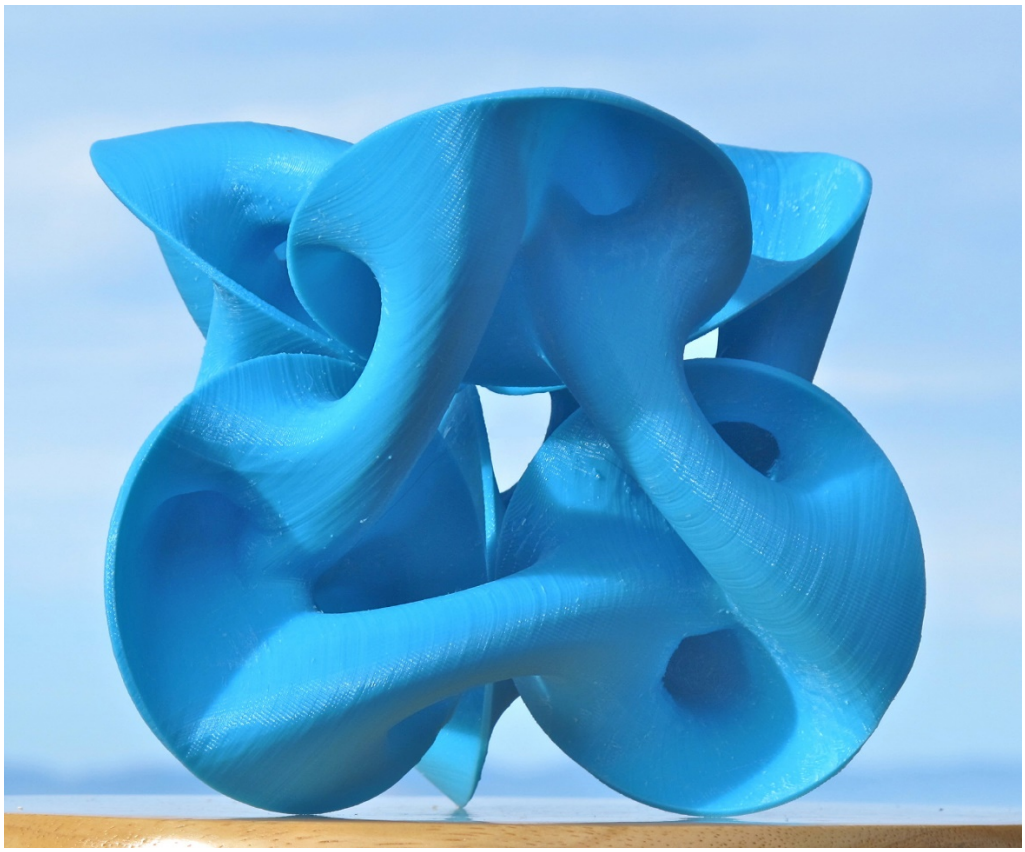

Tetra-Cluster of Seven Klein-Bottles

15 x 15 x 15 cm

3D-print, PLA plastic

2017

The key building block is a “4-stub Dyck funnel”, a disk with a pair of tubular extrusions emerging from both sides. Six of these elements have been placed at right angles to the 6 edges of a tetrahedron; they are mutually interconnected with 12 tunnels. This yields a surface of genus 14 – the equivalent of the connected sum of 7 Klein bottles with 6 punctures, exhibiting the 12-fold symmetry of the oriented tetrahedron.

MAA Golden Section Mathematical Art Exhibition 2019

Dodecahedral-Cluster of 25 Klein-Bottles

24 x 24 x 24 cm

3D-print, PLA plastic

2017

In this expanded second sculpture, based on “4-stub Dyck funnels,” 24 of them have been aligned with the 24 edges of a rhombic dodecahedron, and their stubs have been connected with 48 tunnels. This yields a surface of genus 50 – the equivalent of the connected sum of 25 Klein bottles with 24 punctures, exhibiting the 24-fold symmetry of the oriented cube. It took 132 hours to build this model on a LULZBOT 3D-printer. Manual support removal took several more hours.